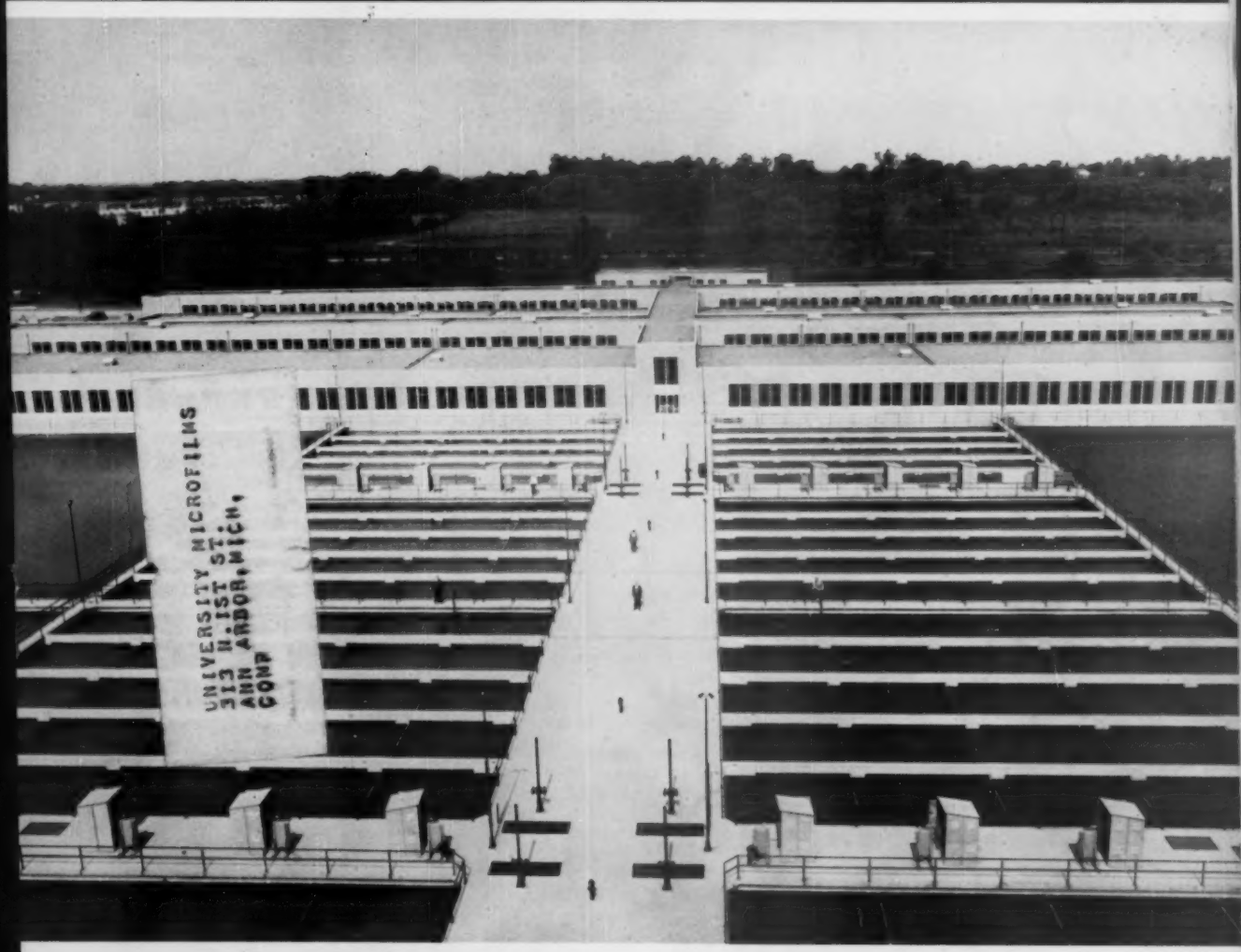
A Scranton Gillette Publication

NOVEMBER 1959

WATER & SEWAGE WORKS

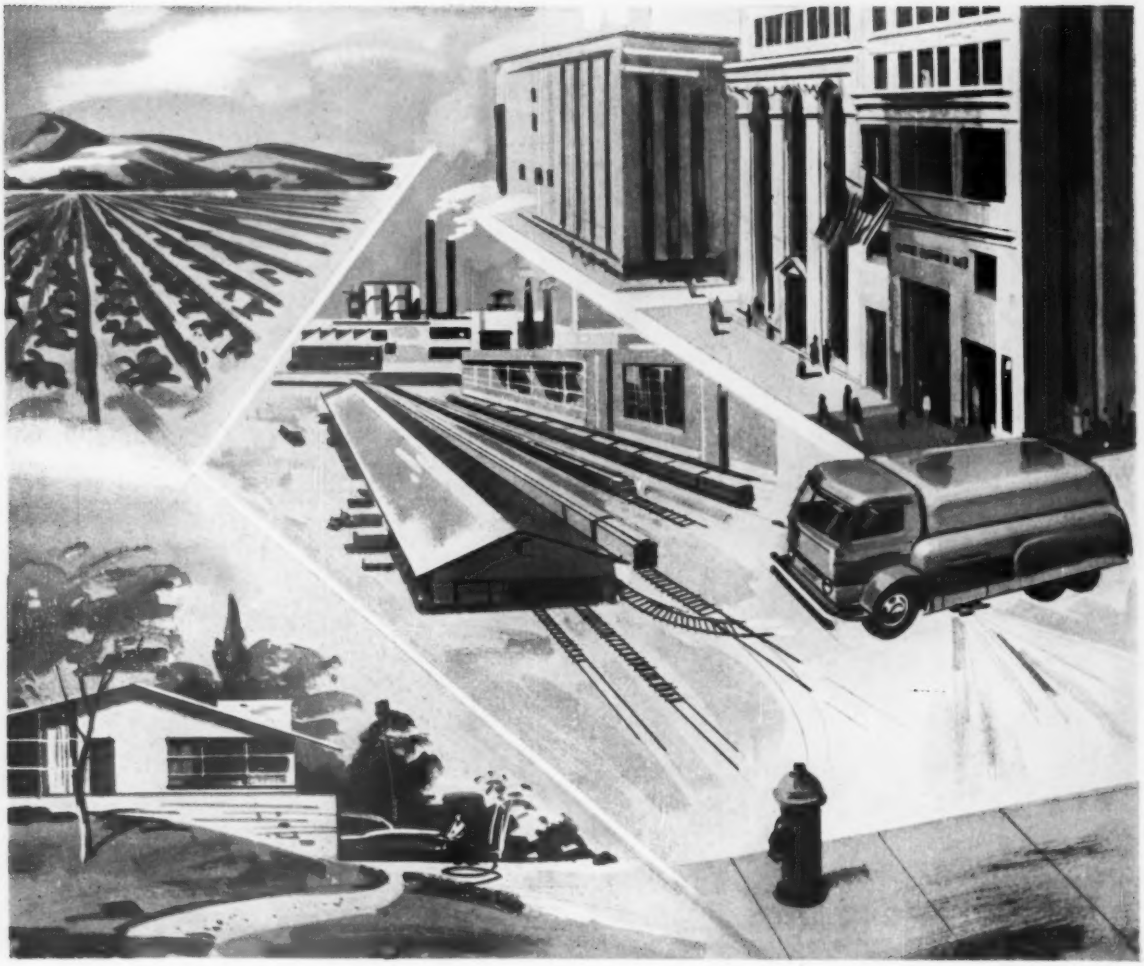
WATER SUPPLY • SEWAGE DISPOSAL



PHILADELPHIA'S $25-MILLION TORRESDALE FILTRATION PLANT, world's largest to be automatically controlled, is shown from atop the five-story pre-treatment building. **See page 461.**

Flow Resistance in Pipes & Fittings p. 465

Utilization of Liquid Sludge p. 489



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Walter E. Deuchler Co., Aurora, Illinois – Consulting Engineers
W. A. Sperry – Superintendent Aurora Sanitary District

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Automatic digester temperature control ■ 180°Boiler heat for building heat
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Exclusive rifled sludge return bend castings
Maximum efficiency using digester gas and/or natural gas or fuel oil

The Walker Process HEATX provides the *complete unit* for your digester sludge heating process. Concentric tube heat exchanger, fire tube boiler and control panel are combined to give absolute control over each function. Exclusive ***rifled*** sludge return bend castings cause sludge to spiral through the exchanger tubes – better K value – wall scouring prevents slime and grease adhesion. ■ The HEATX is available in standard sizes ranging from 100,000 to 2 million BTU/hr. output. Bulletin 24 S82 gives complete description of type EB (with boiler) and type E (without boiler)

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Vol. 106 No. 11
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A Scranton Gillette Publication

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P. F. T. Gas Scrubber Saves Miami Plant $25,000 A Year

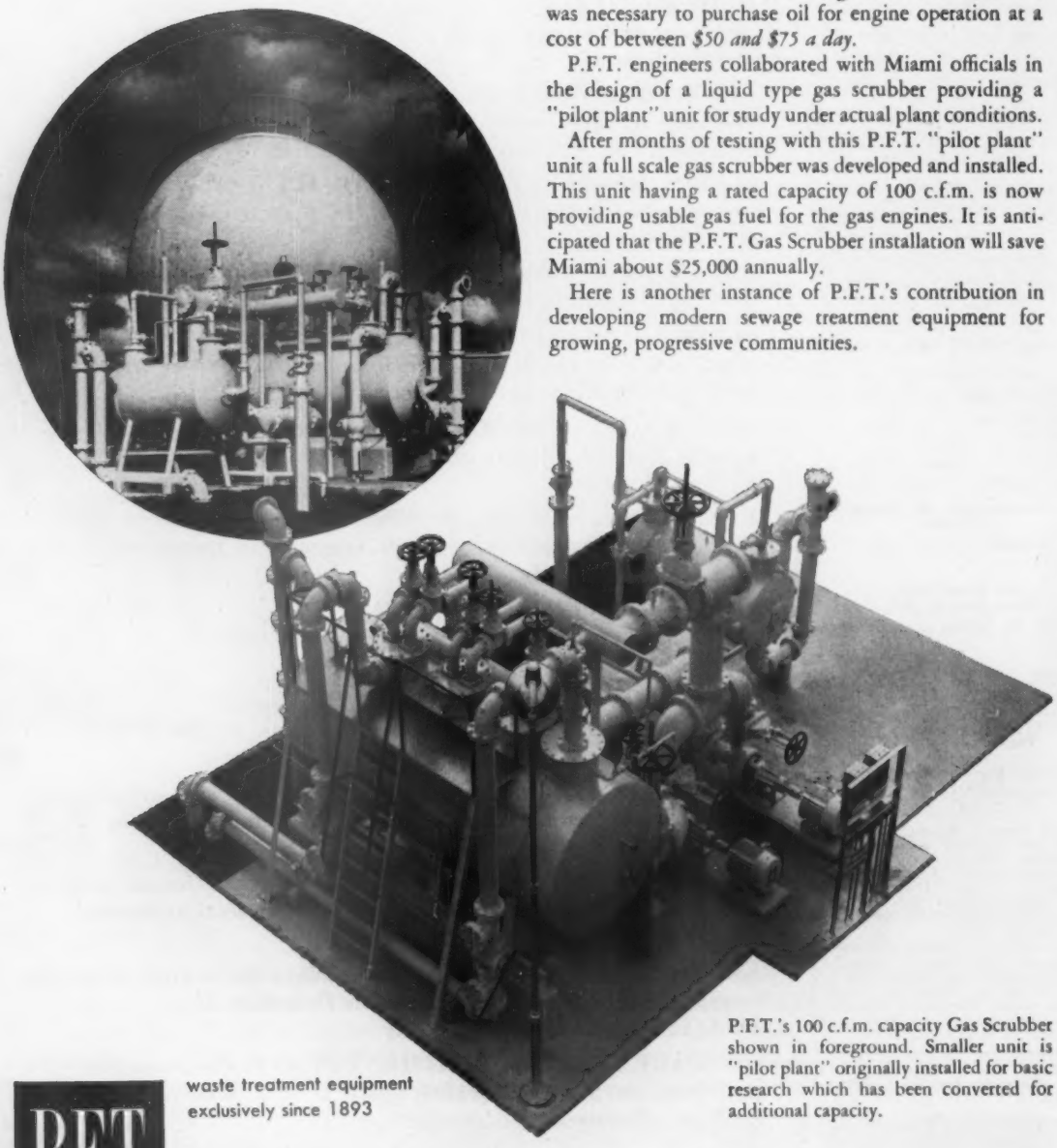
The formation of hydrogen sulfide has been the source of operating and maintenance problems in sewage treatment plants in many sections of our country—Miami, Florida's new plant was no exception.

Normally, sewage treatment plants produce and collect their own gas for fuel use. At Miami the gas was found to have a very high hydrogen sulfide content—so high that it could not be used for engine fuel. Therefore, it was necessary to purchase oil for engine operation at a cost of between *$50 and $75 a day.*

P.F.T. engineers collaborated with Miami officials in the design of a liquid type gas scrubber providing a "pilot plant" unit for study under actual plant conditions.

After months of testing with this P.F.T. "pilot plant" unit a full scale gas scrubber was developed and installed. This unit having a rated capacity of 100 c.f.m. is now providing usable gas fuel for the gas engines. It is anticipated that the P.F.T. Gas Scrubber installation will save Miami about $25,000 annually.

Here is another instance of P.F.T.'s contribution in developing modern sewage treatment equipment for growing, progressive communities.



P.F.T.'s 100 c.f.m. capacity Gas Scrubber shown in foreground. Smaller unit is "pilot plant" originally installed for basic research which has been converted for additional capacity.

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Briefs

Torresdale, Push Button Water Plant—Pictorial report on Philadelphia's new 282 mgd, $25 million plant that accomplishes in 10 acres filtering that formerly occupied 60 acres—Page 461.

Radioactivity in surface waters, a testing program and status study conclude this series of reports on the AWWA Convention—Page 464.

Flow Resistance in pipes and fittings is reviewed in this general paper to provide the engineer with a frame work for solving unusual problems that might occur—Page 465.

Sludge Dewatering—This report on the use of vibrating screens for dewatering sludge is the result of one of the studies conducted by the Wuppertal Sanitary District, Germany—Page 479.

Modernized Water Supply—A consulting engineer reports on the conversion of a water system from gravity flow to pumped supply—Page 484.

East Ridge Sewage Works—Presented the interesting project of the design and construction of a system and treatment plant for an unsewered town in an area where soil and ledge conditions made construction difficult—Page 485.

Utilization of Liquid Sludge—Permitted the abandonment of eluriation, filtration and fertilizer production equipment—Page 489.

Sewer Maintenance Program—Provides a basis for legislation to protect sewers, ideas on infiltration control and sewer cleaning by contract—Page 494.

Diatomite Filters—Replacing outmoded slow sand filters with Diatomite units provided low cost investment and expanded water treatment facilities—Page 496.

Outfall Around the Madison Lakes—This paper reports how Madison eliminated the problem of discharging its effluent into the Madison lakes, thus counteracting the fertilizing effect on algae in these lakes—Page 497.

Explosive Gas Detection—Discusses the formation and operation of the Explosive Gas Detection Unit in San Francisco. Results of a comprehensive testing program are also presented—Page 501.

Compact Sewage Treatment Plant—Solved the problem of hospital sewage disposal in spite of limited land availability, high ground water and tight subsoil—Page 503.

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This chemical building panel provides plant operators with records of key flow variables. Basin and bypass flows are indicated, recorded, and integrated.

Honeywell *FiltermatiC* consoles control all filter valves. Each of eight consoles can control filtering of 8 m.g.p.d., but presently monitors about 2 m.g.p.d.

"Model" water plant at Springfield, Ohio relies on Honeywell automatic controls

Master filter building control panel provides centralized information on key flows, pressures, and levels. Also features central alarm and communication system.

The recently built $5,800,000 water treatment plant at Springfield, Ohio, is a model of efficient, low-cost operation. Treatment variables are measured and/or automatically controlled by a Honeywell system. Black & Veatch, Kansas City, were the consulting engineers, and G. E. Tillman Co., Centralia, Ill., the contractor.

Modern instrumentation techniques were exploited to the fullest in specifying controls for this plant. For example, raw water influent is measured at two separate points, totalized, and telemetered to both the filter building master control panel and the chemical building panel.

Fully pneumatic operators on the filter valves enable effluent to be adjusted either locally or remotely—manually, or automatically from changes in clear well level. This results in optimum flexibility and centralization.

Honeywell controls make every phase of the treatment process a dependably precise, automatic operation at the Springfield plant. For help in applying the latest, up-to-date automatic control to your own water treatment project, contact your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

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News—Here & There

Illinois Adopts Membrane Filter Technique

The Illinois Department of Public Health can be credited as the first State to officially adopt the membrane filter procedure for standard water testing in routine laboratory work.

The membrane filter technique accomplishes in less than 24 hours what formerly took from 4 to 6 days. With more than 150 water tests run daily in the Illinois Department of Health laboratories, the economy of time becomes important.

AWWA Advancement Award

The Board of Directors of the AWWA has established a new awards program to recognize the outstanding community relations accomplishments in each of the 31 Sections in the United States, Canada and Cuba.

The Association will provide a statuette of "Willing Water" for each section to present annually to the water utility judged to have accomplished the most outstanding community relations project within the previous 18 months.

According to Chairman Fred Merryfield, the Advancement Award is designed to stimulate and encourage water utilities to step up their community relations activities to earn more public support for expansion of much needed water supply facilities. Now, for the first time, the Association will be able to publicly recognize the water utilities which have accomplished outstanding community relations objectives.

The rules state: Any Corporate Member, municipal service subscriber or Active Member who is a water utility employee is eligible to submit an entry in his Section's competition.

Each entry must be in the form of a report on accomplishments in community relations activities that have shown definite results in the 18-month period prior to the section meeting. Entries may be based on an over-all program or on activities in one or several of the following categories: customer relations, press relations, cooperation with public agencies, stockholder or governing board relations, advertising, production of a local film, development of a speakers program, employee relations within the utility or employee participation in community affairs.

To submit an entry, a utility representative must give written notification to his Section Advancement Chairman at least two months prior to his Section's annual meeting and must deliver the entry, with supporting exhibits, to the Advancement Chairman at least one month before the Section meeting. Each entry should consist of three basic components: (1) a statement of the objectives of the project; (2) a review of measures adopted to attain the objectives and (3) a report on the results of the program. Exhibits must be limited in size to those suitable for mailing.

The award program will be inaugurated in each AWWA Section at its first meeting after January 1, 1960. No Section will be permitted to make an award in any year in which fewer than three entries are submitted.

Algae in Water Supplies

According to the new manual released by the Public Health Service, one of the smallest and lowliest of plants—the fresh-water algae—may eventually supplement food and forage products and become a new source of vitamins, animal feed, fertilizer and other organic products useful to man.

Designed primarily for water plant operators, the manual identifies the types of algae associated with clean and polluted water, and explains how they may help or hinder production of good quality water.

The role of algae in sewage treatment has become increasingly apparent in recent years. With algae it is possible to support immense populations of aerobic bacteria, and thus greatly accelerate the sewage stabilization process. It is the massive growths of algae developed in sewage stabilization ponds that advancing technology may some day be able to convert into useful products.

The new algae report is the result of an 8-year study by two scientists at the Public Health Service's Sanitary Engineering Center in Cincinnati. They are Dr. C. M. Palmer, algologist, and Harold J. Walter, Biologist and artist.

The 100-page study, with six color plates and many black-and-white drawings, is for sale for $1.00 by the Superintendent of Documents, Government Printing Office, Washington, D.C.

Hersey and Sparling To Merge

Effective January 1, 1960, the Hersey Manufacturing Company, Dedham, Mass., and Sparling Meter Company, El Monte, Calif., will merge.

The combined organizations will be named the Hersey-Sparling Meter Company. Hersey's president, Winthrop P. Hersey, will be president, with Sparling's president, Ray C. Sparling, as vice president. Executive offices will be in Dedham.

The presidents stated, upon conclusion of the discussions which start-

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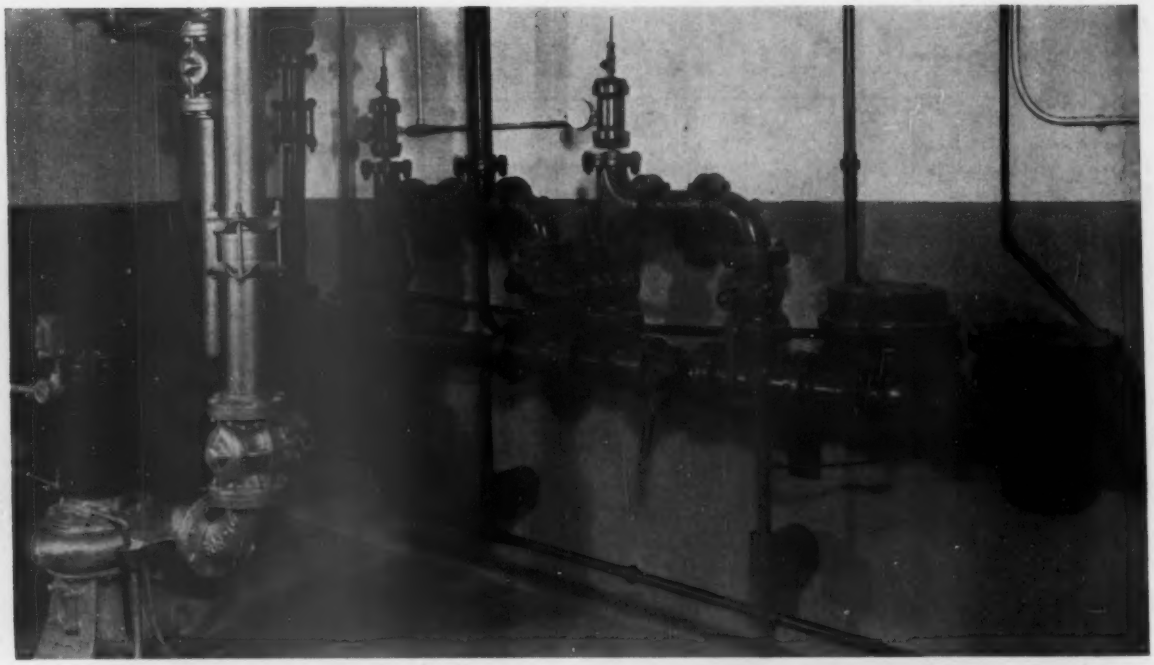
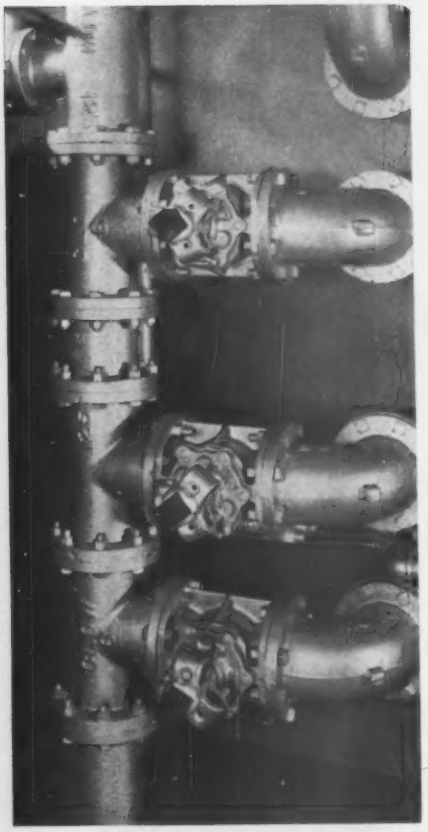


DeZURIK VALVES . . . TOP CHOICE of PRIVATE UTILITIES, TOO!



This unique sewage treatment plant is owned and operated by Huber Utilities of Dayton, Ohio. (Consulting Engineer, Ralph L. Woolpert & Associates of Dayton; Prime Contractor, Christopher Construction Co., Columbus.) The plant is NOT unique in the selection of DeZurik Valves; many sewage treatment plants have made DeZurik Valves first choice. It IS unique in being a privately owned facility built to serve a large housing development by the Huber Company.

The DeZurik Valves pictured above are on gas lines from the digestor; those pictured on the left are supernatant draw-off valves, used to draw supernatant from the primary digestion tank.

DeZurik Valves . . . installed in your plant . . . can give you the same ease of operation, tight shut off and long life they are providing in Huber Utilities. They operate easily because the plug touches the valve body ONLY in the closed position. They close dead-tight WITHOUT LUBRICATION—on gas OR sludge—because of their resilient-faced plug. They give longer life because of their nickel seat.

For more information, consult the DeZurik representative in your area, or write to

DeZURIK CORPORATION
SARTELL, MINNESOTA

News—Here & There

CONTINUED FROM PAGE 7A

ed last December: "Our decision was a natural one, in view of the similar backgrounds of Hersey and Sparling. Both companies are largely family-owned, our research aims are parallel, we have the same management philosophy, the same type of manufacturing experience, and in general our sales lie in similar areas."

"Through this merger the Hersey-Sparling Meter Company will have modern new manufacturing and distribution centers on both the East and West coasts, and branch sales offices in 11 major U.S. cities. In addition, the Company is affiliated with a 200-year-old British manufacturer of water and industrial meters, Tylor's of London, Ltd."

New Saline Water Conversion Process

The General Electric has developed a new process for the conversion of salt or brackish water.

The process is based on a new concept in heat transfer in which the overall resistance to heat flow is decreased through the combined use of thin films of water both for evaporation and condensation.

The process is a result of General Electric's extensive study aimed at evaluating the "thin film" concept in heat transfer.

Using an experimental, concentric, vertical tube distillation unit, thin films of water for evaporation were achieved by spreading the fluid on the inner surface of the tube by means of a slowly rotating wiper. In condensing the vapor on the outer surface of the tube, thin films resulted from the utilization of surface tension.

Overall heat transfer coefficients as high as 8,000 Btu/(hr)(Sq ft)(deg F) were obtained under laboratory conditions with the experimental apparatus.

Current laboratory activities are involved with the construction of prototype test models to prove the feasibility of applying the "thin film" process to various sizes of demineralization equipment. Based on experimental results, applications of the new process point to potential dollar savings through the reduction in cost of energy consumption, initial cost of equipment, and cost of maintenance.

Fred Welsch Honored by APWA

W. Fred Welsch, Senior Hydraulic Engineer, Nassau County, N. Y., Department of Public Works, has received the 1959 Charles Walter Nichols Award of the American Public Works Assn. Welsch was cited for his pioneering and sustained leadership in the development and administration of a program of artificial recharge of ground water with storm water in New York's Nassau County, thereby conserving the area's vital water supply and preventing the intrusion of salt water into the underlying aquifer; and for his technological contribution to the science of ground water conservation at a time when this problem is of growing importance throughout the nation and when his work may encourage other water-short communities to attempt similar procedures.

Welsch, a graduate of Cooper Union and a Registered Professional Engineer and Land Surveyor in New York State, has been with the Nassau County Department of Public Works since 1938. His responsibilities include administering the county water survey programs and serving as Department liaison between local officials of the county's 50 public water supply systems.

Radioactive Pollutants in Water

The Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, has announced that two courses in radiological health will be given during February, 1960.

Radioactive Pollutants in Water, February 8-12, is offered for water supply and water pollution control personnel concerned with radioactive contamination of the aquatic environment. Prior completion of the course "Basic Radiological Health", or is equivalent, is recommended.

Radionuclides in Water, February 15-19, is an extension of the course "Radioactive Pollutants in Water." It is designed for laboratory personnel engaged in water monitoring activities, with emphasis on methods and techniques for determination of those radionuclides of primary health significance.

Major course topics for "Radioactive Pollutants in Water include: (1) sources of radioactive pollutants in water, (2) waste disposal criteria, (3) stream survey techniques, (4) preparation of samples, (5) laboratory counting techniques, (6) gross radiation measurements, (7) establishment of monitoring programs, (8) relation of water monitoring to other phases of environmental surveillance, and (9) beneficial applications of radiation in water analysis.

Agenda topics for "Radionuclides in Water", include: (1) health significance of radionuclides, (2) instrumental techniques for evaluation of beta emitters, (3) alpha and gamma spectroscopy, (4) radiochemical separation procedures, (5) instrument calibration and maintenance, and (6) interpretation and evaluation of analytical results.

Applications should be addressed to the Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Record Sea Water Conversion Unit

What is believed to be the world's longest evaporator has been manufactured by Cleaver-Brooks for Southern California Edison Company's Mandalay Steam Station near Oxnard, Calif.

The unit will be California's first general purpose sea water distillation plant and is the first of its kind in the country to be operated in conjunction with a steam electric power plant.

The plant will have a capacity of 100,000 gpd with an over-all cost of about $250,000. The main component of the 26 stage flash evaporator measures over 70 feet long and weighs 40 tons. The entire unit used over 8 miles of aluminum brass tubing and nearly 50 tons of steel sheet and plate.

Once in operation, an extensive test program will be conducted to explore various operating conditions and characteristics to establish the economics of a multi-million gpd plant.

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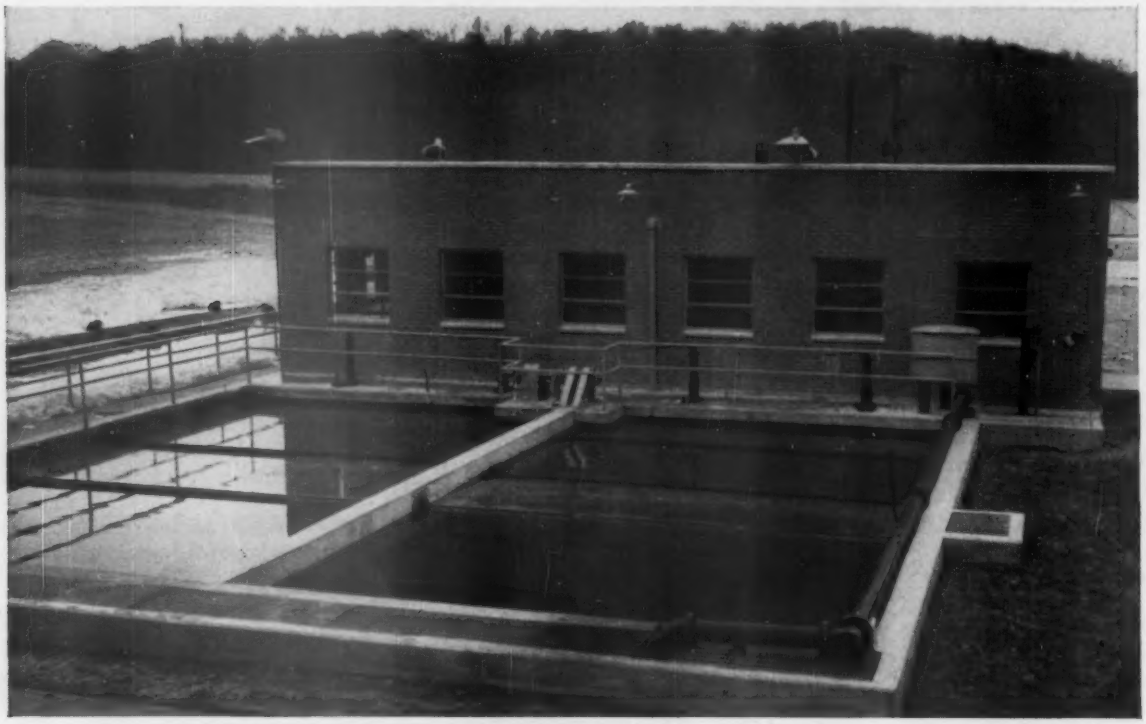
City of Sidney, Ohio

Gets Smooth Measurement of Sludge Magnetically!



...WITH FOXBORO MAGNETIC FLOW METER

"The Foxboro Magnetic Flow Meter on return activated sludge went into operation so smoothly that no one paid any attention to it. They haven't done a thing to it since, and it's still operating smoothly."

That's the comment of W. D. Sheets of Ohio State University, Technical Adviser for the new Sidney, Ohio, sewage plant. It's a typical perfect-performance report on the Foxboro Magnetic Flow Meter, a modern flow meter that's always easy to install, simple to operate, practically maintenance-free.

No line restrictions — no pressure taps to plug up. With the Magnetic Flow Meter, there's nothing in the line to cause pile-up of solids. And you can forget about purging of pressure taps — there aren't any! Electrical cable carries measurement signal to remote Dynalog* Electronic Recorder, providing a direct magnetic measurement of fluid velocity. Get full details on this unique development in flow meters. Write for Bulletin 20-14A. **The Foxboro Company, 8911 Neponset Avenue, Foxboro, Mass.**

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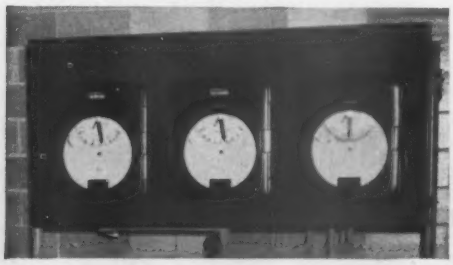
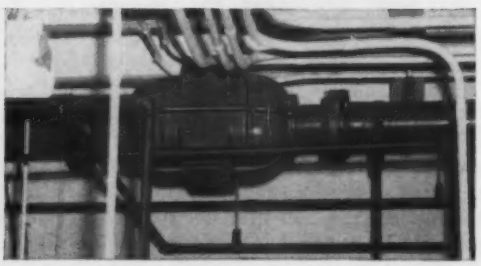
FIRST in FLOW

All Flow measurements are recorded by Foxboro Instruments centrally located in the plant director's office of the Sidney plant. Shown below, left to right, are: Air Flow Recorder with integrator; Sewage Flow Recorder with integrator; Dynalog Recorder for return activated sludge.





This compact, troublefree Foxboro Magnetic Flow Meter is installed right in the return activated sludge line at Sidney, Ohio's modern new sewage plant. There's nothing in the line to obstruct flow in any way . . . no pressure taps or purges.

News—Here & There

CONTINUED FROM PAGE 9A

Biological Waste Treatment Conference

Manhattan College, New York, N. Y., has announced its third Biological Waste Treatment Conference, to be held on April 20, 21, and 22, 1960.

The object of the conference will be to present advances in aerobic treatment since the 1955 conference on the same subject.

The symposia planned will cover the Theory of Bio-oxidation, Aeration and Oxygen transfer, and Treatment and Process Applications.

Wesley Eckenfelder, Associate Professor, stated that papers from allied fields such as microbiology, bio-chemistry, and fermentation processes will be welcome.

Water Bacteriology Course

Recent Developments in Water Bacteriology is the title of a course scheduled by the Robert A. Taft Sanitary Engineering Center for the week of January 25-29, 1960.

This one-week course is offered for professional bacteriologists in positions of responsibility in State, municipal, and other laboratories engaged in water analysis. Personnel from industry and universities are welcome.

The course consists of lectures and extensive laboratory practice on standard procedures used in bacteriological water analysis, with primary attention on the procedural details shown by laboratory surveys to be most frequently overlooked or misunderstood. Equal time and attention are given to the theory and practice of newer methods of bacteriological water analysis, including membrane filter techniques and detection and enumeration of enterococci in water.

Course agenda include: (1) bacteria which indicate pollution; (2) new approaches in water bacteriology research; (3) problems of viruses in water; (4) recent developments in water biology; (5) epidemiology of waterborne disease; (6) examination of water for coliform and enterococcus groups; and (7) examination and analysis of laboratory methods and membrane filter techniques.

Applications should be addressed to the Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Radioactivity Measurement in Texas Waters

The Texas State Department of Health and the University of Texas have announced that the investigation of the radioactive content of state waters has been extended for 10 months.

The two agencies signed a contract in December, 1957, to establish the study. Extension of the contract will make available additional monies to complete the investigation by next June 30.

The probe involves a "background" radioactivity survey of all major surface and underground streams, as well as some coastal water, to establish present levels of radioactivity.

Sponsors said that more than 1,600 water samples from stations in 18 river basins have been collected by game wardens cooperating in the study. The information gathered should be valuable for many years as a reliable reference for measuring increases in radioactivity.

Miami's Water & Sewer System Financing

Officials of Ira Haupt and Co., New York investment banking firm, have offered to pay costs estimated at $50,000 for a master plan for a $60 million Dade County Florida water and sewer system and to buy all the bonds if it proved feasible.

Commissioner Arthur Patten told a meeting of the Dade County Metropolitan Commission water committee that officials of the firm said "we could finance a $60 million system immediately with revenue bonds alone —no general obligation bonds—at a rate around 3.5 percent."

In turn, the commission would give the firm a chance to match the best offer it might receive from any other investment banking firm on selling the issue. If the commission accepted another firm's offer, it would rebate Haupt for preliminary engineering costs.

Nevada May "Milk the Clouds"

Hugh A. Shamberger, director of the Nevada State Department of Conservation and Natural Resources, suggested that Nevada may have to milk more moisture out of the high Sierra cloudbanks if it is to keep up with the water needs of an expanding population.

His observations were made in a study of Nevada's present and anticipated water problems requested by U.S. Senator Robert S. Kerr, chairman of a select committee on national water resources.

Shamberger recommended that a research program on "Weather modification" be instituted as rapidly as possible to increase snowfall on high watersheds in northern Nevada and thus swell spring and summer runoffs.

Sacramento's Water Supply

Sacramento, California City Manager Bartley W. Cavanaugh recommended submission to the electorate in November of a $25 million revenue bond issue to finance city water system improvements, including a $10,452,000 filtration plant on the American River near Sacramento State College.

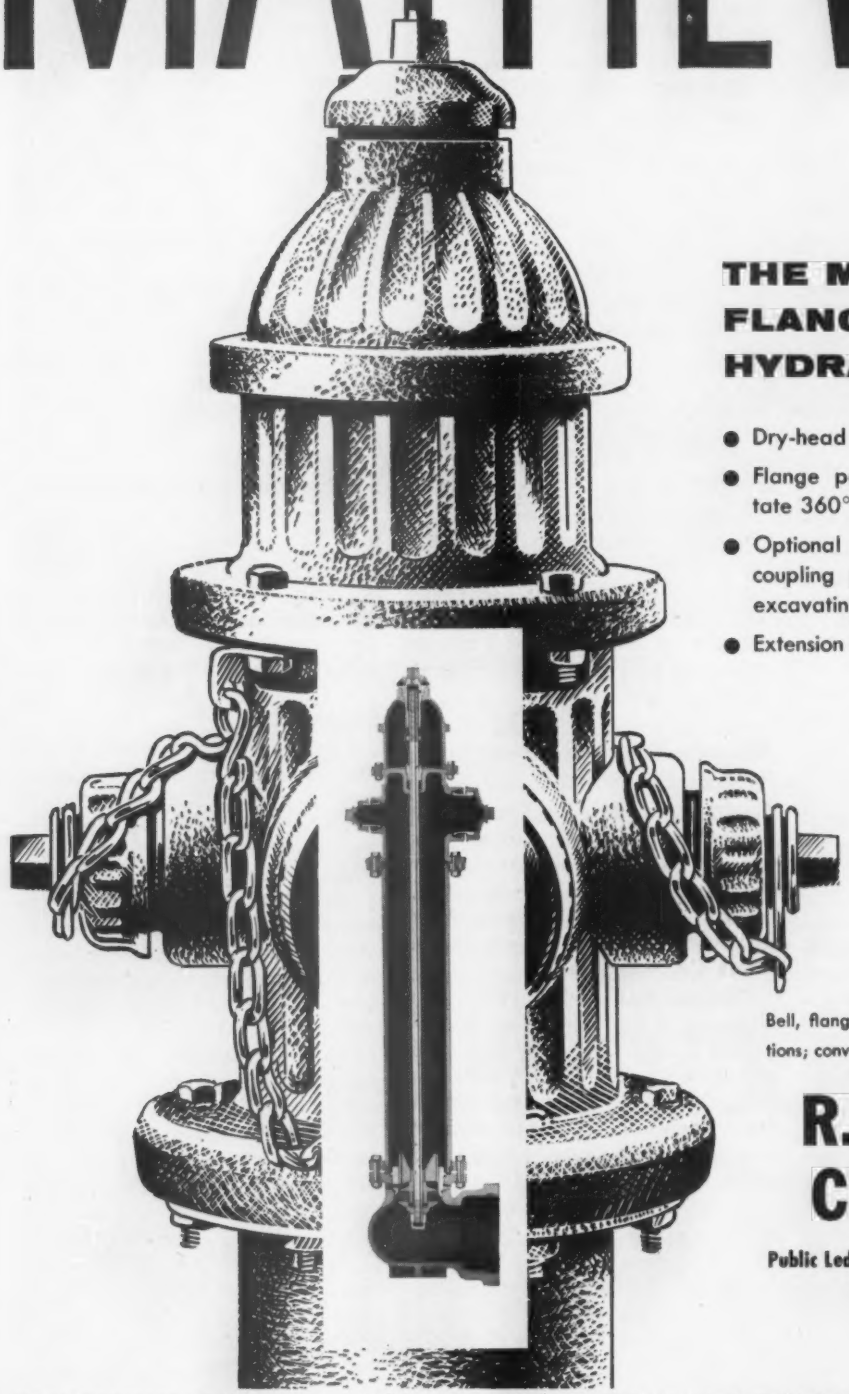
Proceeds of the proposed 40-year bond issue will finance the development of the first five years of a 70 year master plan for the city water system prepared by the James Montgomery engineering firm of Pasadena.

The improvements are designed to expedite deliveries of water impounded by Folsom Dam. Such deliveries are guaranteed under a contract between the city and the Federal Bureau of Reclamation.

Other installations will include reservoirs, 32 miles of major pipelines, a booster station and a facility in the Riverside District for the removal of hardening agents.

The bonds will be paid off from water service charges and will not require a tax increase, according to Cavanaugh, who said: "There will have to be a substantial increase in water rates, but even taking this into account Sacramento will still have the lowest water rates of any city in California."

MATHEWS



THE MATHEWS FLANGE BARREL HYDRANT

- Dry-head construction
- Flange permits nozzle section to rotate 360°
- Optional breakable flange and stem coupling permits replacement without excavating
- Extension section available

Bell, flange or mechanical-joint pipe connections; conventional or "O" ring packings

R. D. WOOD COMPANY

Public Ledger Building, Independence Square
Philadelphia 5, Pa.

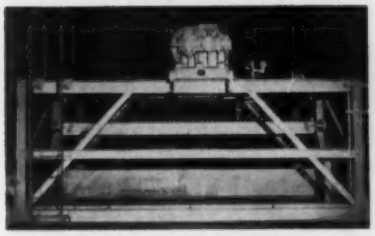
Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

Equipment News

Mechanical Rake

1101

Frank W. Stuker and Associates, Buffalo, N. Y., has introduced an improved type of mechanical rake for cleaning debris from trash racks or screens in front of gates where water is required in large volume, as encountered in pumping, processing and sewage disposal installations.



The rake is self-guiding, self-clearing and self-dumping to provide thorough removal of trash ranging from light debris to heavy waterlogged materials. They safeguard gates, valves, pumps, turbines and other equipment to reduce interruptions to service and costly repairs. They can be made to start and operate automatically on signal from remote control or differential water level.

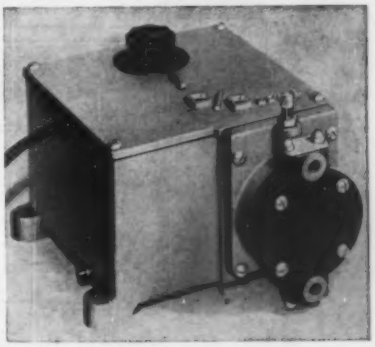
Electrically driven mechanism handles a complete range of depths with low power consumption. Easy one-man operation makes it possible for the Stuker rake to travel across the face width of rack bars extending across the forebay.

Chemical Metering Pump

1102

CC Pump Division, Clark-Cooper Co., Palmyra, N. J. has announced a new addition to their line of Controlled Capacity Chemical Metering Pumps—a diaphragm pump designed for positive displacement metering of a wide range of corrosive and non-corrosive liquids. The pump will satisfy requirements of high accuracy, low flow metering with four flow ranges available up to the maximum of 2.5 gallons per hour. Hydraulically balanced Teflon diaphragm eliminates flexing fatigue and distortion of flow rate.

The new pump operates against back pressures as high as 500 psi and wetted parts can be constructed of many materials such as plastic, stainless steel, nickel, etc. Construction



includes built in overpressure relief valve. Operating mechanism is totally enclosed and completely submerged in oil. Available in multi-head construction and for automatic proportioning from pneumatic or electric impulse signal.

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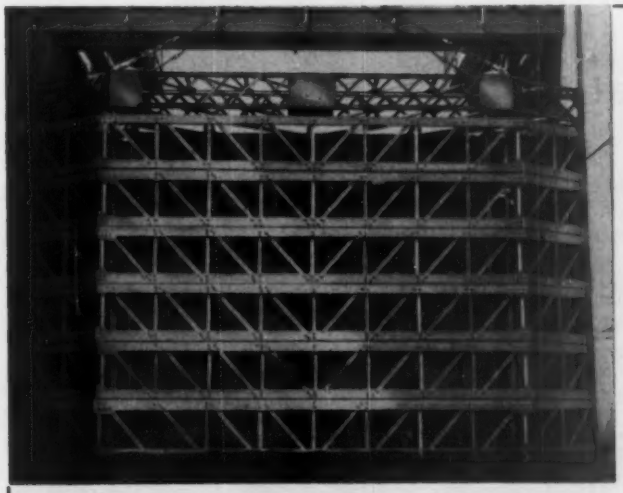


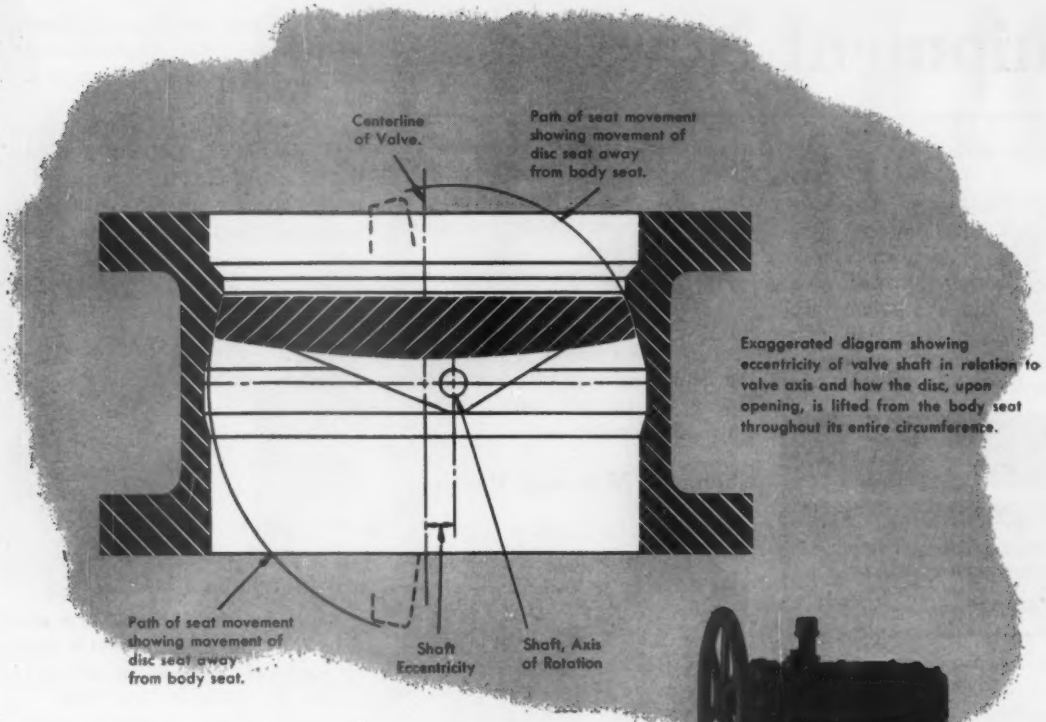
FROM BIG 38 FT. ALUMINUM FLOOD GATE TO SMALL STOP PLATE

No matter what your water and sewage equipment need . . . Washington Aluminum is your answer

Engineers who want to reduce installation costs and corrosion problems specify Washington Aluminum maintenance-free equipment. Washington Aluminum proven-in-use design and fabrication products makes this name a mark of distinction on every installation.

Among Washington Aluminum products are: Non-skid walkways, Sluice gates, Ladders, Aeration trays, Suspension bridges, Manhole covers—and all types of custom-fabricated products. If it should be aluminum . . . it should be made by Washington Aluminum.

WASHINGTON ALUMINUM COMPANY, INC., Dept. 711
BALTIMORE 29, MARYLAND


Centerline of Valve.
Path of seat movement showing movement of disc seat away from body seat.
Exaggerated diagram showing eccentricity of valve shaft in relation to valve axis and how the disc, upon opening, is lifted from the body seat throughout its entire circumference.
Path of seat movement showing movement of disc seat away from body seat.
Shaft Eccentricity
Shaft, Axis of Rotation

How **DARLING-PELTON BUTTERFLY VALVES** lick common problems!

Problem No. 1—COMPLETE SHUTOFF. With a continuous, 360 degree, rubber sealing ring, uninterrupted by the valve shaft, *drop-tight* shutoff becomes possible!

Problem No. 2—SEAT LIFE. With the valve disc swinging on an axis eccentric to the valve centerline, the disc lifts away from the body seat upon opening—abrasion and distortion are avoided. Moreover seat life is further prolonged by easy, compensative adjustment.

Problem No. 3—MAINTENANCE. Minimized and simplicity itself due to the unique seat ring principle. No sealing problem around the shaft. The rubber seat is replaceable in or out of the line without dismantling the valve!

Get *all* the facts on performance, sizes and constructions made to A.W.W.A. Specifications. Send for Bulletin 5904.

DARLING
DARLING
VALVES

DARLING VALVE & MANUFACTURING CO.

Williamsport 11, Pa.

Manufactured in Canada by The Canada Valve & Hydrant Co., Ltd., Brantford, Ont.

Equipment News

CONTINUED FROM PAGE 13A

Diaphragm Pumps

1103

Marlow Pumps, Division of Bell & Gossett Co., Midland Park, N. J., has just announced the addition of two new models to their line of lightweight aluminum diaphragm pumps. An electric motor unit is known as the Model 302B-EL while a gasoline engine unit is designated as the Model 302B-1.

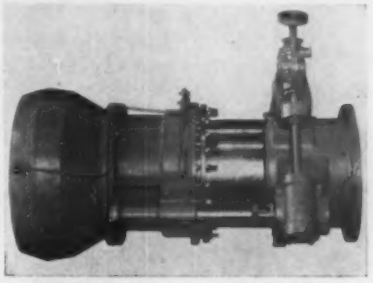
Both units have 3" male-threaded suction and discharge. They use standard diaphragms and have replaceable rubber flapper valves. The valves and valve seats can be replaced quickly if required. The gear case and pump body are made of cast aluminum. The body has a readily accessible clean-out and drain hole. Either model is available as a base or wheel-mounted unit.

"Ring-Jet" Valve

1104

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has announced a new Ring-Jet valve designed for easy regulation and control of water under free-discharge.

The new design retains most of the advantages of the Howell-Bunger valve in that it provides easy free discharge regulation with high dis-



charge coefficient. It is equipped with a hood to minimize the spray and to admit air to the jet.

The new valve incorporates the simplicity of construction, radially balanced hydraulic design and easy operation of the Howell-Bunger valve while very nearly matching its high discharge coefficient.

The Ring-Jet valve is available in 17 sizes from 18 to 108 inches.

Pneumatic Transmitters

1105

Simplex Valve and Meter Co., Lancaster, Pa., has announced the addition of a group of Pneumatic Transmitters to its line of products for the water, sewage and industrial wastes fields. These transmitters work on a 3-15 psi signal and are accurate over a wide range of flows.

There are two types—the PN for Rate of Flow and the TD for loss of Head and they offer many advantages over previous units. They are compact, easy to install and maintenance free.

The rate of flow transmitter or Simplex Type PN transmitter combines the accuracy and range of a mercury float operated differential converter with the dependability of pneumatic transmission. It produces a linear signal without the necessity of supplementary pneumatic relays and offers point accuracy over wide ranges of flows with minimum differential. The transmitter produces a standard 3 to 15 psi signal while consuming less than .1 CFM of air.

The loss of head transmitter or Simplex Tupe TD is a simple, com-

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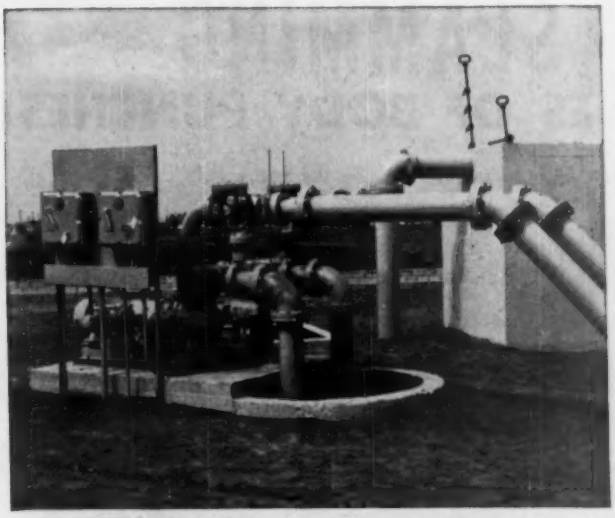
HIGH and DRY...not way down in the pit... GORMAN-RUPP SEWAGE PUMPS



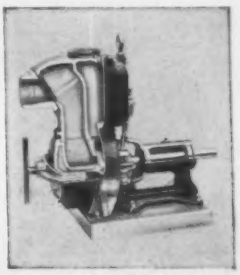
Twin installation of Model 14A2-B at a sewage treatment plant, Clair-Mel City, Tampa, Fla. Controls alternate pumps at regular intervals.

COST LESS TO BUY—Self-priming in lifts up to 15', positive in action, nearly completely non-clogging. High and dry, their installed cost has allowed savings of as much as 50%.

COST LESS TO MAINTAIN—Almost no maintenance needed! No need to service by entering pit or raising pump. Just a turn of the wrist and the end plate is off.

PERFORM WHERE OTHERS FAIL—In lift stations and sewage plants, these Gorman-Rupp units have shown amazing records of savings . . . operating where others have failed. Let us show you examples.

2", 3", 4" and 6" pumps—connected to your power or ordered complete with power units. Write for complete specifications.



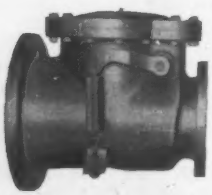
FAST-ACTION END PLATE—Exclusive end plate releases for access to impeller and wear plate. Two-vane open impeller specifically designed for handling spherical solids.

THE GORMAN-RUPP COMPANY

305 Bowman Street • Mansfield, Ohio

CHECK VALVE SLAMMING

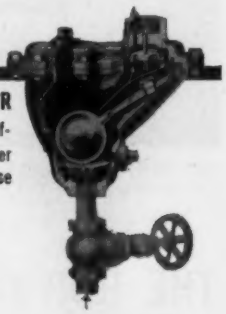
IS LIKE A SERIES OF BODY PUNCHES!



Little by little it "softens up" a pump discharge line for the final knock-out. Moderate slamming causes leakage, throws pipes out of line or causes other damage that may go undiscovered for years. Heavy slamming often causes serious damage and service interruption.

Why risk trouble and service loss? Ludlow and Rensselaer List 340 non-slamming check valves *are non-slamming under the most severe conditions,* thanks to adjustable spring tension. They are recommended as standard equipment wherever slamming is likely to occur.

WRITE TODAY for L&R Check Valves Catalog, showing 3" to 30" sizes, with or without lever arm and spring. All materials and workmanship exceed the A.W.W.A. requirements for gate valves and fire hydrants.



POSITIVE CONTROL OF AIR INLET OR DISCHARGE is afforded by Ludlow or Rensselaer air and vacuum and air release valves.

LUDLOW & RENSSELAER

VALVES AND HYDRANTS

THE LUDLOW VALVE MANUFACTURING CO., INC., TROY, N. Y. — SINCE 1861

MUELLER®

Products and people, dependably serving every water and gas distribution system — for over a century!

Supplying a constant flow of water and gas to your home or your industry requires highly specialized tools and equipment.

For example, this Mueller automatic drilling machine is used to drill into mains to make new connections and to add valves while the main is under pressure — *without shutting off the flow of water or gas.* The operator needs only to check the visual indicators to see how the automatic cut is progressing.

Today, because of the dependable performance of the thousands of products developed by Mueller people for the water and gas industries, the constant, safe control of gas and water is taken for granted.

MUELLER CO. DECATUR, ILL.

Since 1857

CL-12 Drilling Machine for cuts from 2" to 12".

Equipment News

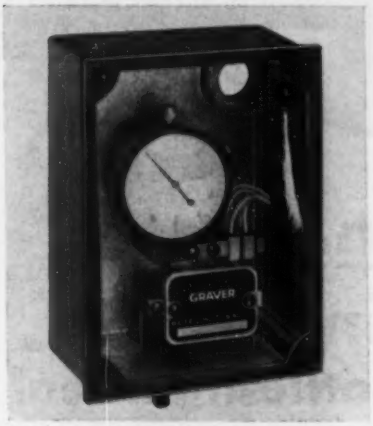
CONTINUED FROM PAGE 15A

pact, dependable and accurate instrument of the Force-Balance principle. The unit is small, rugged, self draining and venting and has a calibrated accuracy within ±1% over the range of 0-144 inches of water. Its construction has eliminated stuffing boxes, levers, pivots or relay valves and is provided with an external zero adjustment.

In addition, the two transmitters can be assembled as one compact unit. This greatly simplified the piping necessary and cuts down on installation and maintenance costs.

Clarifier Overload Protector
1106

Graver Water Conditioning Co., New York, N. Y. has developed the Protecta-Trol, an overload indicator and controller for water clarification units. The device registers sludge overload on an indicator and has contacts for alarm or light signals and for shutdown of the unit. It is being



offered as regular equipment on Graver Reactivator high-rate, solids-contact clarifiers and softeners, and Roto-Rake Clarifiers, horizontal flow gravity separators.

Protecta-Trol is housed in a galvanized cast iron, weather-tight assembly. It works off the input worm of the speed reducer which is spring loaded so that any increase in load above a present point causes the worm shaft to compress the spring and allows the shaft to move. The

CONTINUED ON PAGE 23A

There's no waste water from a V-notch

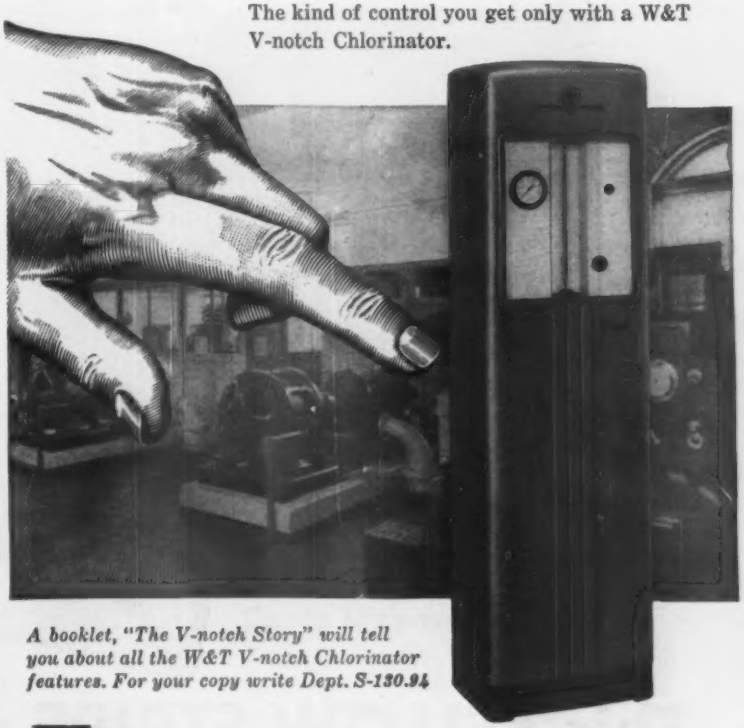
Why?

Because a V-notch Chlorinator needs no auxiliary water supply.

You can plan on clean, dry chlorinator rooms with no messy drain—no chlorine gassing back. And best of all... gone forever is the high cost of wasted auxiliary water.

And, of course, the right plastics make the whole chlorinator chlorine-proof.

Yet these are just added benefits to the main job: Simple, dependable, wide range chlorine control. The kind of control you get only with a W&T V-notch Chlorinator.



A booklet, "The V-notch Story" will tell you about all the W&T V-notch Chlorinator features. For your copy write Dept. S-130.94

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET. BELLEVILLE 9, NEW JERSEY

is your feeding problem peculiar to your operation?

Wallace and Tiernan's volumetric feeders are so flexible that each job is practically custom built. W&T's experience is broad enough to meet any challenge.

Try us - for information write Dept. MV-1.94

WALLACE & TIERNAN INCORPORATED
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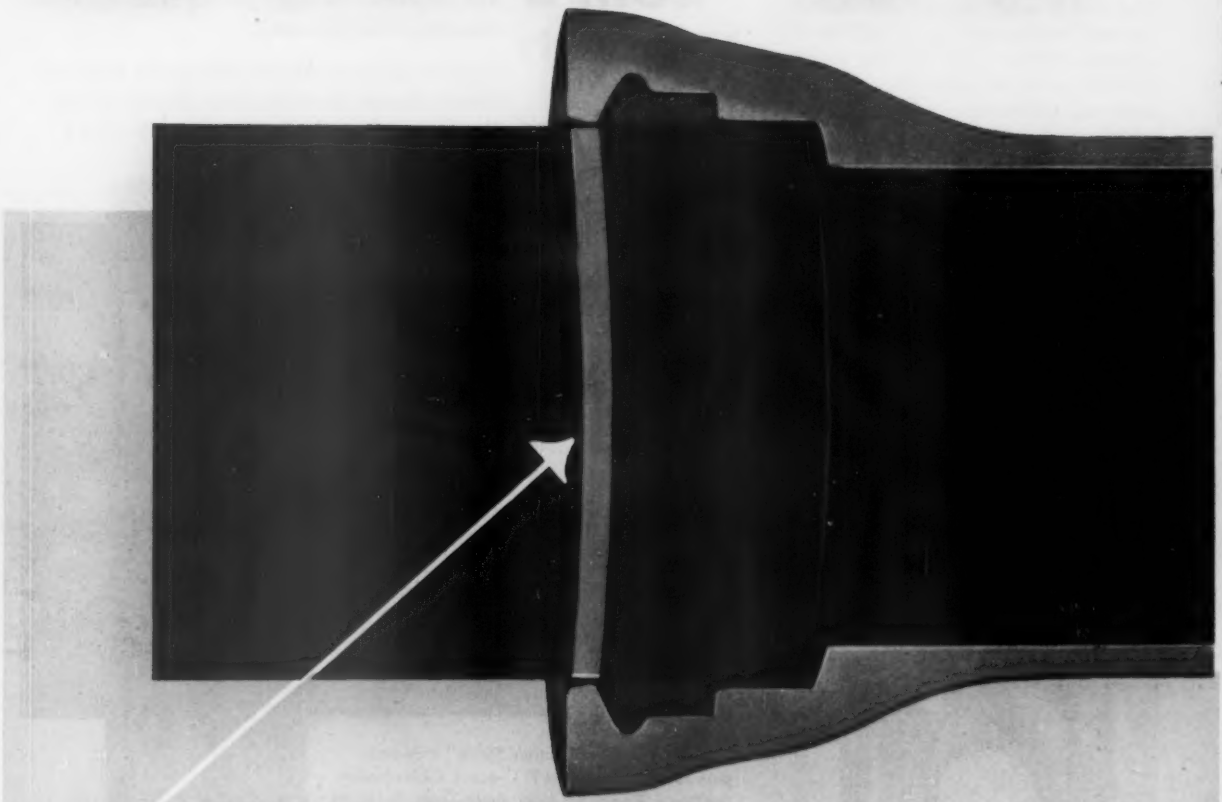
CLOW



This YELLOW STRIPE on

CLOW Bell-Tite Joint Pipe

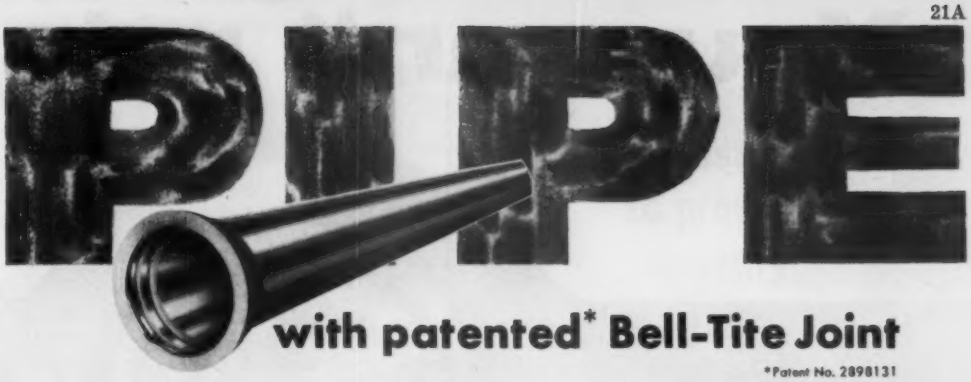
is your guide line to a quick bottle-tight seal

This circular yellow stripe is painted on the plain end of each length of CLOW Bell-Tite Joint pipe. It serves as a guide in making up the joint, to provide a fast, positive visual check that the the joint is completely and correctly assembled.

The edge of the stripe farthest from the plain end measures approximately one-half inch less than the depth of the Bell-Tite bell. Thus, in assembly, the joint is made pressure-tight when the stripe is no longer visible.

The seal is achieved by the use of a single, thick-section, high durometer molded rubber gasket. When compressed in position by the entering plain end of pipe, it forms a pressure-tight seal with generous sealing area which permits ample deflection to meet casual curves or grades.

CAST IRON



with patented* Bell-Tite Joint

*Patent No. 2898131

MORE MAIN FOR YOUR MONEY

Costs less to buy

Only one accessory is required to make a pressure-tight seal with a CLOW Bell-Tite Joint —a single, molded rubber gasket. There are no extras—no bolts, no nuts, no followers, no couplings. This economical pipe is strong, tough, uniform and durable for long-life underground service. It is available in any specified thickness or weight class in accordance with ASA, AWWA, or Federal specifications from 3" to 24".

Costs less to install

Assembly is quick, simple and easy. Pressure-tight joint is formed instantly by merely inserting the rubber gasket and pushing the pipe home to its seat. It can be installed in a wet trench and even under water. Rate of installation usually is limited only by speed of excavation. It permits ample deflection for casual curves or grades. Bell-Tite Joint pipe is Underwriters' Listed for working pressures up to 350 psi. Available in diameters up to 24".

CLOW CAST IRON PIPE

JAMES B. CLOW & SONS, INC.

201-299 North Talman Avenue, Chicago 80, Illinois

Subsidiaries:

Eddy Valve Company
Waterford, N.Y.

Iowa Valve Company
Oskaloosa, Iowa

You can't miss!

There's Visibility Unlimited in

ROCKWELL

Sealed Register

METERS

You can't miss getting a quick, accurate reading from any Rockwell Sealed Register meter. A row of bold figures look you straight in the eye through a window that never becomes dirty or fogged. In fact you can even run this meter under water. That's because the register and all the reduction gears are *hermetically sealed* to stay clean, dry and free of condensation.

With Rockwell Sealed Register meters you'll never again be called upon to service leaky or bound stuffing boxes *for there are none.* A powerful magnetic drive couples the measuring chamber to the register without mechanical linkage or seals. And in this revolutionary meter there are only two moving parts operating in water. Truly, the Rockwell Sealed Register meter is the least vulnerable to wear or corrosion—the smoothest running and most accurate. Write for catalog. Rockwell Manufacturing Co., Pittsburgh 8, Pa.

Now available
in both 5/8"
and full 3/4" sizes

SEALED REGISTER METERS

another fine product by

ROCKWELL

Equipment News

CONTINUED FROM PAGE 19A

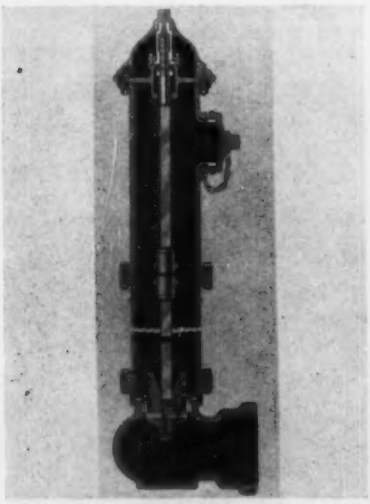
moving shaft actuates a sending plunger which causes movement of a pointer on a scale. The plunger, by making direct mechanical contact with the drive mechanism, produces an actual torque reading.

The new device is a companion to Graver's hydraulic lifter introduced a year ago. The latter lifts the sludge scraper arms during overload so that the arms can freely rotate over the surface layer of sludge. In this way, the scraper can work down through the sludge until the overload condition is cleared up. With Protecta-Trol an operator can instantly tell when overload occurs and can just as easily put the hydraulic lifter into action.

New Hydrant

1107

A. P. Smith Mfg. Co., East Orange, N. J. has developed the model H100 fire hydrant, featuring bronze-to-bronze seat ring threads, permanent lubrication, and a unique design seat removal wrench. The model



H100 hydrant conforms to current AWWA specifications and is produced with 4⅝" and 5¼" internal valve openings for working pressures up to 150 lbs. When equipped with a high pressure pilot valve, the hydrant is suitable for working pressures up to 200 lbs.

CONTINUED ON PAGE 28A

In the background, a section of the new filtration plant at Miami, Fla. Thoroseal protects all its masonry.

Specify Thoroseal

Thoroseal is not a thin paint. It is a cement-based product which goes on in a heavy coat and actually becomes a part of the masonry beneath it and positively seals it against the erosion and penetration of moisture. It goes on quickly and easily—especially with our new wide brush technique. It pays to remember that when you are protecting masonry, the best product is always the least expensive. Standard Dry Wall has been in business since 1912. Its products speak for themselves.

Please send me your free new specification guide.

Name_____

Address_____

City_____ Zone____ State_____

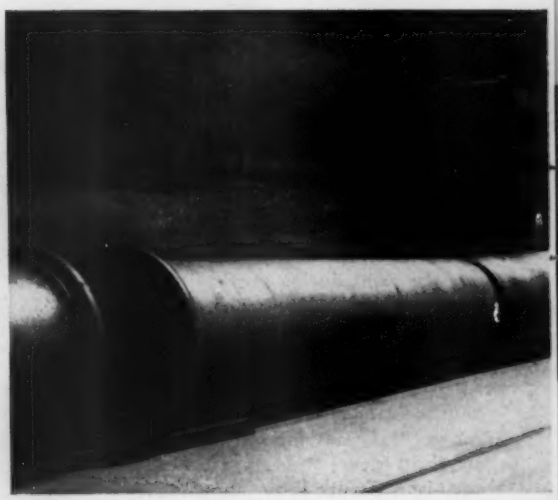
Standard | **Dry Wall Products, Inc.**

Box X-(4) New Eagle, Pa.

Plants at New Eagle, Pennsylvania and Centerville, Indiana

"I PREFER CAST IRON PIPE TO ANY

Recently a questionnaire was mailed to water utility managers all over the U.S.A. One question asked was: *What kind of pipe do you prefer and why?* With 42 states heard from, the vote is overwhelmingly in favor of cast iron! Here are typical comments:



"Strength, resistance to corrosion . . . economical first cost, low maintenance and operating cost, good flow characteristics."

—North Carolina

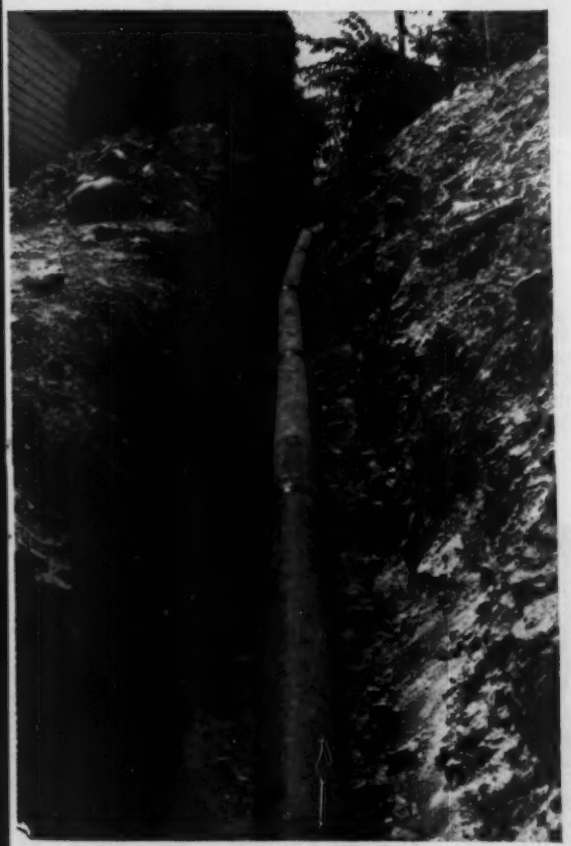
"Our main system is entirely cast iron. It holds up good in 'hot' soil conditions and will not rust out. We are nearing the century mark on some of it, and it gives no trouble."

—Kansas

"Long life—strength—ease of tapping. We are located, as a city, over old mine workings, and subsidence of earth causes trouble on other pipe to a greater extent than on cast iron."

—Illinois

OTHER KIND"



"We have a very hilly city, pressures up to 170 p.s.i. Some of our mains are 90 years old. They were cast iron and are still giving good service."

—Iowa

"Having been used over a long period of time, it has proved its worth. Structurally safe. Easy to repair."

—California

So many good reasons...

- LONG LIFE. The cast iron pipe you install today will be performing economically a hundred years from now.
- HIGH CAPACITY FLOW. Cement-lined cast iron pipe will deliver the full-rated flow all through the years. No other pipe, size for size, can carry more water.
- CORROSION RESISTANCE. Long life proves it. Most water utilities are still using the first cast iron pipe they installed.
- GREAT BEAM STRENGTH. Cast iron pipe resists the effect of heavy traffic, shifting soils.
- TREMENDOUS LOAD RESISTANCE. 6" cast iron pipe (Class 150) withstands a load of nearly 9 tons per foot!
- PRESSURE-TIGHT JOINTS. You have a complete choice of leakproof, easy-to-assemble joints. You need a minimum of tools and work crew.
- EASE OF TAPPING. No tapping saddles needed. Takes threading best of all kinds of pipe.

...good reasons for you *to choose*

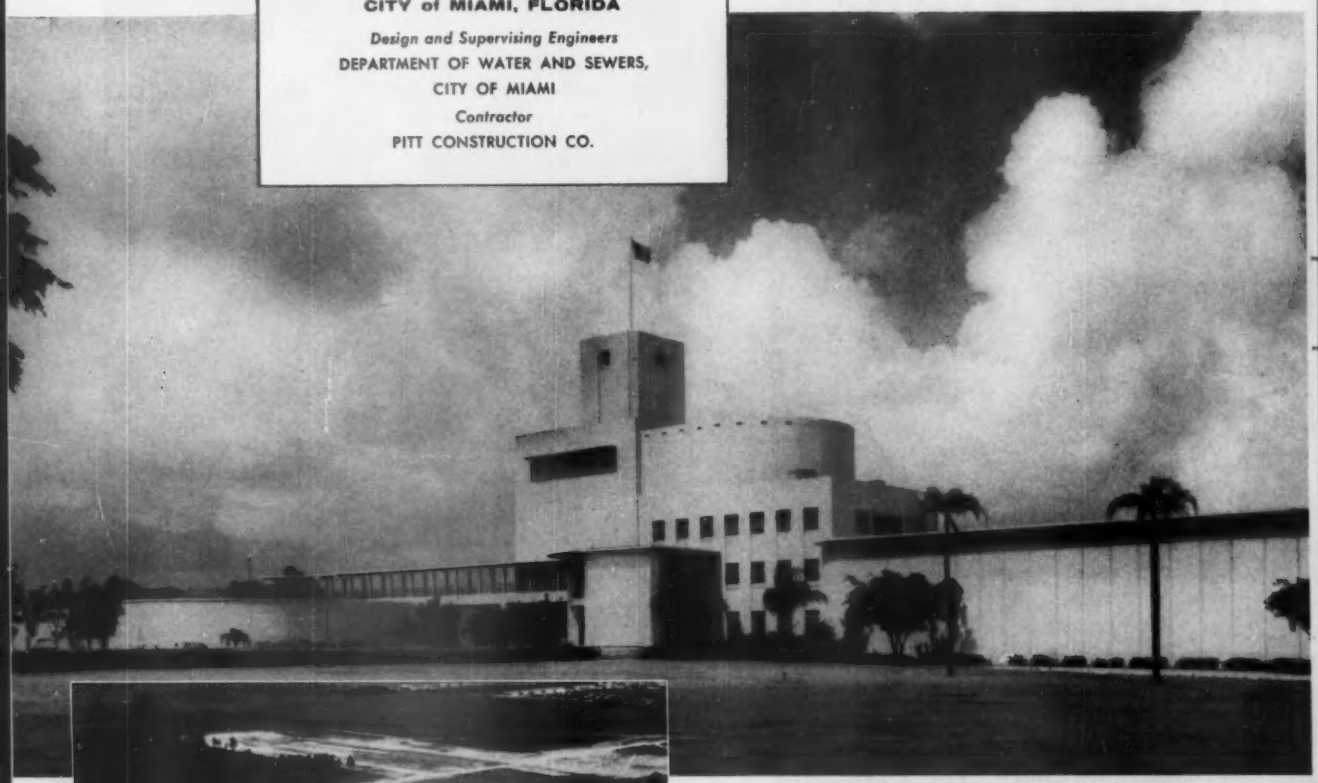
CAST IRON PIPE

THE MARK OF THE 100-YEAR PIPE

Alexander Orr, Jr. Water Treatment Plant
DEPARTMENT of WATER and SEWERS
CITY of MIAMI, FLORIDA

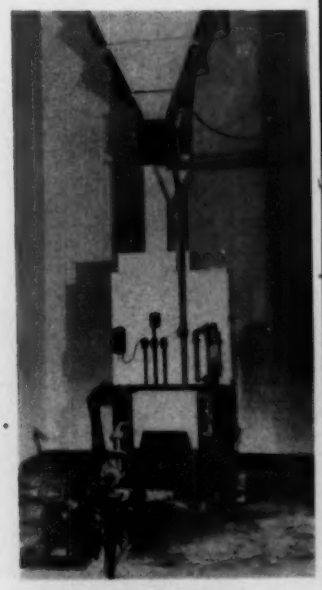
Design and Supervising Engineers
DEPARTMENT OF WATER AND SEWERS,
CITY OF MIAMI

Contractor
PITT CONSTRUCTION CO.



Modern, excellently designed exterior complements the highly efficient facilities at the Orr plant.

Aerial view shows the extensive layout required to treat water from the high capacity wells in the Everglades and at plant site.



Modern Builders Filter Control Tables centralize individual filter operation . . . display output and head loss data . . . allow remote operation of the large hydraulically-operated Builders Butterfly Valves used for washing, draining and operating filters.

Omega Fluoride Feeder automatically feeds exact Sodium Silico-fluoride requirement into water after recarbonation in response to signals sent to feeder from Builders Venturi meter that measures input flows to plant.

ONE SOURCE
ONE RESPONSIBILITY

POSITIVE CONTROL OF *MATERIALS IN MOTION* BIF METERS FEEDERS CONTROLS

Providing Pure Water for the Magic City...

INTEGRATED CONTROL EQUIPMENT FURNISHED BY SINGLE, RESPONSIBLE SOURCE!

B-I-F equipment controls 100 MGD capacity at Miami's new Alexander Orr, Jr. Water Treatment Plant.

A vital part of the greater Miami water system, the modern Orr treatment plant is a complex operation where complete integration of all control equipment provides maximum operational efficiencies, economies, and reliability.

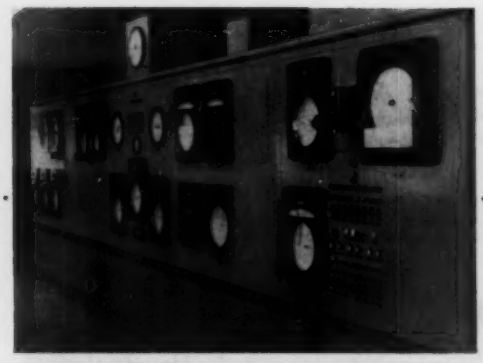
B-I-F Industries, single, responsible supplier of all supervisory control, filter control, chemical feeding and related equipment, brought immediate and long term savings in both time and money. How? By providing better coordinating of efforts during the planning, installation and start-up stages of the project. For full particulars, contact any one of B-I-F's nationwide sales and service offices, or write . . .

B-I-F Industries, Inc., 350 Harris Ave., Providence, Rhode Island.

BIF

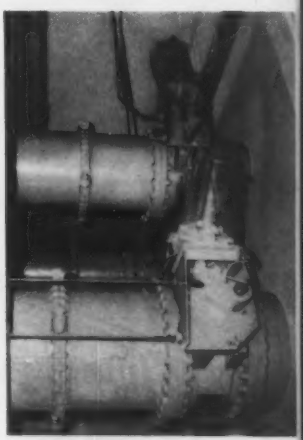
B-I-F INDUSTRIES

BUILDERS-PROVIDENCE · PROPORTIONEERS · OMEGA



Builders Master Control Panel serves as centralized information center for operating entire plant. Panel provides supervisory control of well field, indicates all flows entering and leaving plant, indicates amount of chemicals being fed, and pressures both at plant and in downtown area.

Builders Rate-of-Flow Controller and Diaphragm Pendulum Unit provide simple, rapid rate-of-flow setting for economical filter operation. Self-actuated, these durable units conserve head, assure accurate flow control.

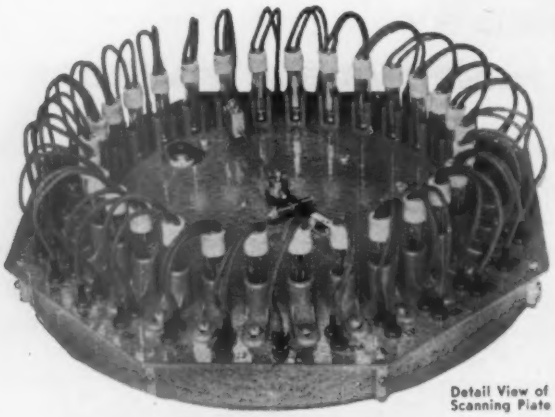


Compact Builders rubber-lined AWWA Butterfly Valves are equipped for both automatic and manual emergency operation . . . have many exclusive design features for efficient "bubble-tight" operation.

After more than 10 years of research and field testing, Autocon now offers you Telescan . . . the multiple signalling telemetering system. Ideal for operating valves, pumps, gates, motors, alarms, indicating and recording devices over any distance.

Autocon

TELESCAN



Detail View of Scanning Plate

SELF-MONITORING TELEMETERING SYSTEM PROVIDES RELIABLE SIGNALS OVER LOW COST WIRES

RELIABLE

Assures maximum reliability . . . checks itself 10 times every minute. Fail safe. Cannot send or receive false signals.

VERSATILE

Provides up to 28 on-off or proportional signals, traveling bi-directionally or in a loop over one pair of wires. Brief interruptions will not disturb Telescan's signalling.

ECONOMICAL

Uses lowest cost telegraph (15 pulse) wires.

SIMPLE

Designed to be maintained by your operating personnel. Switches are permanently sealed in glass against dust and corrosion. The synchronous arm motor operates under conditions equal to those of an electric clock.

But these are only a few of the many features. Telescan is more than a telemetering method . . . Telescan is a complete control system!

To get all of the Telescan story, call your local Autocon representative or write direct to:

AUTOMATIC CONTROL COMPANY

999 University Avenue • St. Paul 4, Minnesota

Standard and custom engineered control systems for water, sewage and processing for more than a quarter of a century.

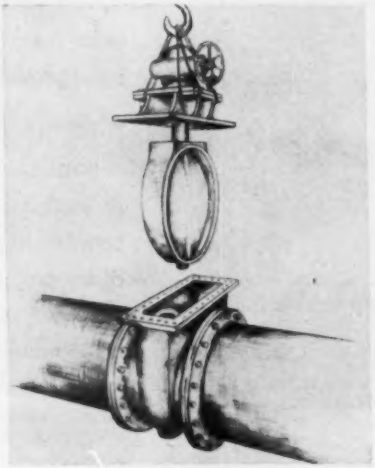
Equipment News

CONTINUED FROM PAGE 23A

Cartridge Type Butterfly Valve

1108

Allis Chalmers Mfg. Co., Milwaukee, Wis., has developed a prototype of a butterfly valve that can be quickly and easily replaced without necessitating complete removal from the pipe line.



In the conceptional model of a new cartridge type butterfly valve the valve vane and seat assembly would be removable leaving the body connected to the piping. It is estimated that in the smaller sizes, a spare unit could be placed into position in about an hour.

Readily accessible bolts in the cover would enable maintenance personnel to quickly reach the inside of the valve, the body of which would have a bolted-on bonnet. The valve could be mounted in a variety of positions depending upon piping arrangements. Sizes would run from 12 to 48 inches.

Non-Caustic Grease Cleaner

1109

Fine Organics, Inc., Lodi, N. J. has developed a safe, inexpensive chemical cleaner to remove the grease from sludge lines. Unlike caustic lye compounds usually used for this purpose, the new F. O. -287 Grease Cleaner Concentrate provides a method of degreasing that is free from

CONTINUED ON PAGE 98A

your best customers are the ones you never hear from!

AQUA NUCHAR

ACTIVATED CARBON FOR TASTE AND ODOR CONTROL

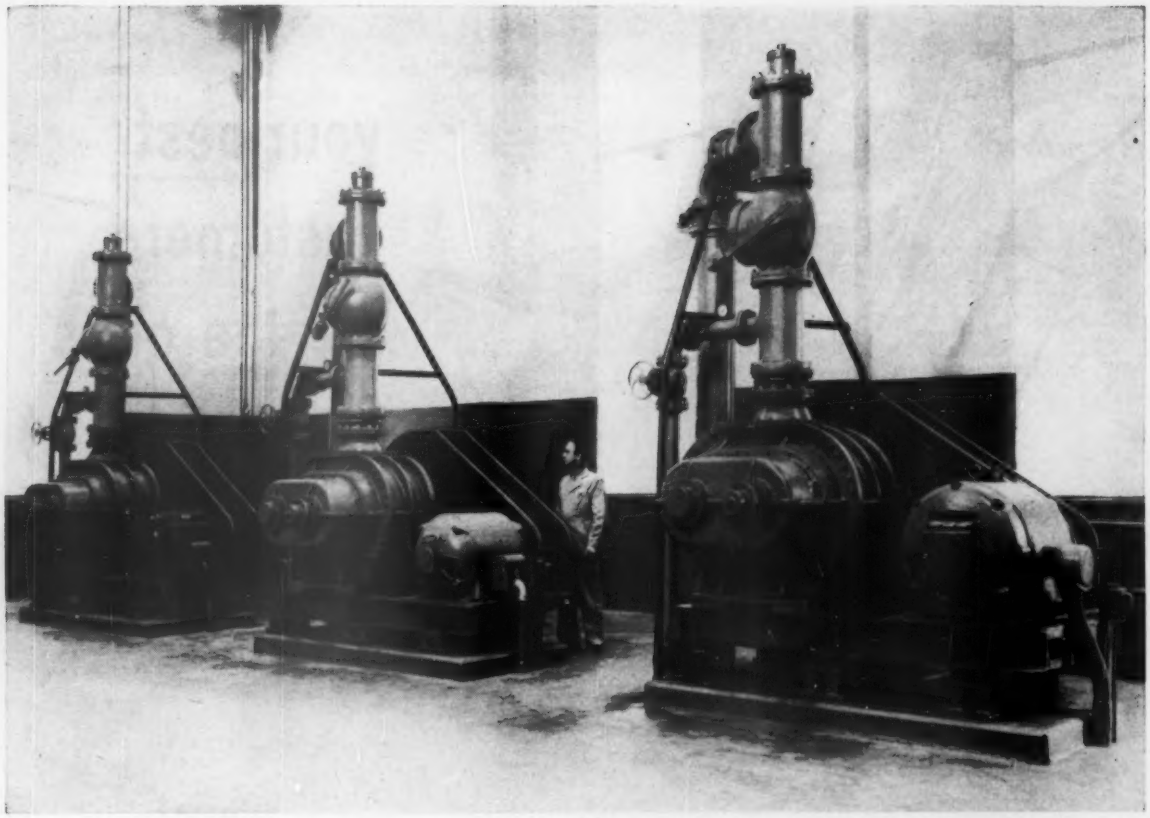
You keep customers happy and complaints at a minimum when you eliminate taste and odor problems with daily threshold odor tests and adequate dosages of AQUA NUCHAR Activated Carbon.

AQUA NUCHAR's unique surface adsorbs tastes and odors from algae, decaying vegetation, trade wastes and other matter . . . leaves "sweet", sparkling water with perfect, consistent PALATABILITY. Concentrations required average as low as 2–5 ppm. AQUA NUCHAR is economical, too.

Our field technical service staff will be happy to assist you in setting up a PALATABILITY program in your plant. Call or write us today.

industrial CHEMICAL SALES
division west virginia pulp and paper company

230 Park Ave., New York 17 · Philadelphia National Bank Bldg., Philadelphia 7 · 35 E. Wacker Dr., Chicago 1 · 2775 S. Moreland Blvd., Cleveland 20



These three 18 x 18 heavy duty Sutorbilt blowers operate at 350 rpm, deliver 2400 cfm against 7 psig . . . operate continuously for many, trouble-free years. San Jose Sewage Treatment Plant.

SUTORBILT BLOWERS MINIMIZE AIR CONTAMINATION

You can depend on Sutorbilt Positive-Pressure Blowers and Gas Pumps to deliver clean, dry air or gas for many years, without costly maintenance and loss in efficiency. Reasons include precision-machined, wide-face herringbone gears, extra-rugged exclusive Sutorbilt timing hub, heavy-duty anti-friction roller bearings . . . closely-held tolerances throughout. Grease and oil seals, or in some instances, a five ring packing gland, insure integrity of air seal where shaft passes through the blower headplate.

Write for illustrated brochure giving complete specifications.

Representatives located in principal cities. Consult your classified telephone directory.

FULLER COMPANY GENERAL AMERICA TRADE MARK

SUTORBILT IS WELL BUILT

CORPORATION, 2966 East Victoria St. • Compton, Calif.

Subsidiary of Fuller Company, Catasauqua, Pa.

ROTARY POSITIVE-PRESSURE BLOWERS AND GAS PUMPS WITH VERTICAL OR HORIZONTAL MOUNTING

1164
B-11

use MUELLER® *angle meter stops*

. . . the angle meter stop with "O" ring seal!

Heavy phosphor bronze spring washer under cap seats the key and permits it to be unseated slightly for easy turning.

Large bronze cap protects ground key surfaces and includes strong, accurate check. Downward force on cap unseats key slightly for easy turning. Flat head or lock wing.

Shear-resistant silicon bronze drive-lock pin solidly anchors cap to key.

"O" ring gives dependable, water-tight, **double** seal at top of key and prevents leakage when key is unseated during operation of stop.

Square bronze ring solidly secures meter coupling nut and permits it to swivel freely. Nut is drilled for wire seal.

Heavy inverted bronze key is accurately machined and individually ground and lapped into the body for water-tight contact over its entire seating area.

Inverted key design uses water pressure on key as additional seating force. The higher the inlet pressure, the greater the seating force.

Single side port in key permits rotation of key 180° from "open" to "closed" position. Greater ground key sealing surface gives longer stop life.

Heavy water works bronze body, key, cap and coupling nuts give maximum strength and resist corrosion.

Opposed convex surfaces of the coupling give line contact initially to permit joint to be made-up quickly and easily.

End of riser pipe flange is not compressed by convex surfaces and gives greater resistance to pipe pulling out.

Mueller Copper Service Pipe Connection inlet includes regular Mueller Copper coupling nut and eliminates loose connecting ring. Meets AWWA specifications.

Extra long skirt on coupling nut supports pipe and prevents leaky joints due to riser pipe movement.

Before your next water meter installation, carefully consider these features. They are typical of the great attention to detail in research, design and engineering which becomes a part of every Mueller product made for the water industry. Mueller Angle Meter Stops are available in a complete range of sizes and styles. Write for complete information.

MUELLER CO.

DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

Mr. J. N. Browning is Commissioner of Water for the City of Sioux Falls. The Waterworks Operator shown here on duty during backwashing is Mr. Rudolph Steinlicht.

JAMES A. COX, Plant Engineer of Sioux Falls, S. D., Waterworks, says:

"Lime treatment of our water doesn't clog our porous underdrains"

"When we added this plant to our system in 1955, we decided on ALOXITE® aluminum oxide bottoms with Anthrafilt for the filter media. Up to then, we'd used graded sand filters with mushroom orifices.

"Our peak load of 18 MGD is easily handled by ten filters. We remove temporary hardness, also iron and manganese, by the lime process. Recarbonation stabilizes the effluent from the sedimentation basins. After recarbonation we add 1-ppm sodium phosphate to the water to insure a stable water on our filters and underdrains.

"Some of the water runs as high as 600 ppm hardness, which we knock down to about 200. Yet the Anthrafilt is as black as the day it went in. There's no sign of lime carbonate coating on it or the ALOXITE filter plates.

"With this porous filter bottom, we find backwashing very fast, very uniform. We get exceptionally good expansion of the filter media too. There's no mud ball problem at all.

"Proper handling of the lime treatment, and careful installation of the filter bottoms have paid off for us. The ALOXITE plates are standing up very well, and have required no service since they were put in."

CARBORUNDUM

Registered Trade Mark

Dept. X-119, Refractories Division, Perth Amboy, N. J.

Another *FIRST!*
The New *AMERICAN*
ALL BRONZE
FROST BOTTOM METER

- Snaps cleanly at the same breaking pressure as a cast iron bottom.
- Internal Metal Parts – Meter Body – Frost Bottom . . . all made of Bronze. No dissimilar metals exposed to water.
- Complete Frost Protection to all working parts in both water lubricated and oil-enclosed gear train models.

Actual photograph of Bronze Frost Bottom after freezing.

Bottom does not drop out when broken. It is kept from falling by the flange bolt heads.

Now for the first time, a true frost-bottom water meter of all bronze construction. This new AMERICAN Water Meter maintains all of the superior features and dependable qualities of the cast iron bottom type, proven in more than 37 years of service.

Should the meter freeze, the center section breaks out at 500-550 psi, to relieve strain on all internal parts. Type and place of fracture are controlled by design. It breaks by tension, not by shearing of projecting lugs. Bottom casting is machined to establish predetermined breaking pressure that is independent of the tightness of the flange bolts. Thus, every AMERICAN Frost Bottom Meter breaks in the *same* manner, at the *same* pressure, at the *same* place!

When the frost bottom breaks, all interior parts, including the gears, separate and move with the ice to avoid damage. After a freeze-up, only the bottom has to be replaced — a low cost, easy operation.

If you have meter freezing problems, investigate the new cost-saving ALL-BRONZE, AMERICAN Frost Bottom Meter. Write for literature.

BUFFALO METER COMPANY
INCORPORATED

2909 Main Street
Buffalo, New York

BASIC...

FOUNTAIN OF YOUTH, 1880... The well of the Little Red Schoolhouse was a popular, if not always healthful, gathering place for children. The old tin dipper in its lip-to-lip travels carried more than its share of disease.

THE MODERN DRINKING FOUNTAIN... eliminates the community cup... substitutes for it clean, pure, safe water distributed nationwide over a network of dependable cast iron pipe.

U.S. PIPE

FOR WATER, SEWERAGE AND

U. S. PIPE AND FOUNDRY COMPANY

but better than ever today!

Care and precision from mine to main insure U. S. Pipe quality

The nation's health depends largely on water. And most of this water is distributed through cast iron pipe.

U. S. Pipe, therefore, exerts every effort to make its product dependable, long-lived and trouble free. From mining of ore... through blast furnace... to final shipping, every length of U. S. Cast Iron Pipe is checked and rechecked for quality.

This end-to-end supervision is another reason U. S. Pipe measures up to the promises made for it... and to the responsibilities placed on it in service.

QUALITY BEGINS HERE . . . at one of U. S. Pipe's mines near Birmingham where ore is mined.

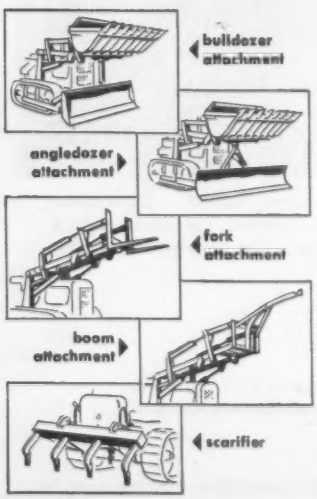
PIPE NEWLY CAST . . . 24" diameter and 18 feet long rolls out on skids from centrifugal casting machine.

SCIENTIFIC TESTING . . . Determining the chemical properties of U. S. Pipe, one of many quality checks.

INDUSTRIAL SERVICE CAST IRON

Birmingham 2, Ala. *A wholly integrated producer from mines and blast furnaces to finished pipe.*

BUY THE LOADER THAT DOES MORE FOR YOU–OLIVER OC-126



...one work-test will prove it

Let your Oliver distributor demonstrate this versatile materials handler that can do more for you than any other machine—the Oliver OC-126 loader. Besides performing the usual loading, stockpiling and excavating jobs with the standard 1½-yd. bucket, the OC-126 mounts many other quick-change attachments to handle a variety of municipal assignments.

Now with "Spot-Turn" clutch steering, the OC-126 adds further to its usefulness with safe, locked-track pivot turns that permit cramped-area operations, faster work cycles. With four forward and two reverse you get the right speed for every job, too. And there is plenty of power when you need it in the 60 h.p., gas or diesel, high-torque engines.

Add to this a selection of 1¼-yd. rock or 2½-yd. snow buckets, bucket clearance of over 10′, 44° bucket roll-back, and 3′ digging depth, and you have the most useful municipal materials handler you can own. Ask your Oliver distributor to prove it to you on one of *your* jobs today.

THE OLIVER CORPORATION
Industrial Division, 19300 Euclid Ave., Cleveland 17, Ohio
a complete line of industrial wheel and crawler tractors and matched allied equipment

why no picture?

A picture can be deceiving. Almost all plastic pipe looks the same . . . and even looks like metal pipe. The difference is a matter of time . . . and piping that goes wrong can be mighty expensive for a water works manager. A picture means nothing . . . but . . .

There are scores of brands of plastic pipe on the market . . . made of a dozen different materials . . . wonderfully improved over the early plastics. All are labeled "rust resistant" . . . but total results may be good, bad, or indifferent depending on your choice. Here's what to look for:

The universal material? No such thing. No one plastic (no *metal*, for that matter) can handle *all* liquids . . . no one has all the properties required of a truly universal pipe. Closest to it are Ace Riviclor (Rigid PVC) and Ace-Ite (ABS rubber-plastic blend). Riviclor is a little better on chemical resistance, and Ace-Ite is a little better on impact strength and heat resistance. Both are OK for drinking water and also for chemicals used in treating water. Of course they're immune to rust, rot, soil and electrolytic corrosion. And they both cost about the same.

Are plastics fully approved for drinking water? Yes . . . the National Sanitation Foundation at University of Michigan attest with their seal that they regularly test Ace Riviclor, Ace-Ite, Ace Supplex and certain of our other brands of plastic pipe, and certify them non-toxic. These materials are odorless and tasteless as well as non-toxic.

Are plastics strong enough? Hundreds of water works and thousands of chemical plants (all very critical people) say *yes!* Plastic pipe is now available in several wall thicknesses for working pressures to 490 psi. It takes plenty of hard knocks, and resists accidental cutting and damage quite satisfactorily.

Where do I use it? Ace-Ite and Riviclor have been used with wide success for years in water and sewage works for feeding a host of treatment and regenerating chemicals . . . chlorine, alum, ferrous sulfate, ferric chloride, etc. They outlast ordinary metals many times over, at prices much lower than special metals.

Greatest future use is in service lines and small water mains, now under extensive study. We've supplied miles of pipe for successful installations. If you haven't yet put some underground for test, it's time to start. Nothing takes the place of *personal* experience. (Also, try Ace Supplex flexible polyethylene for temporary lines.)

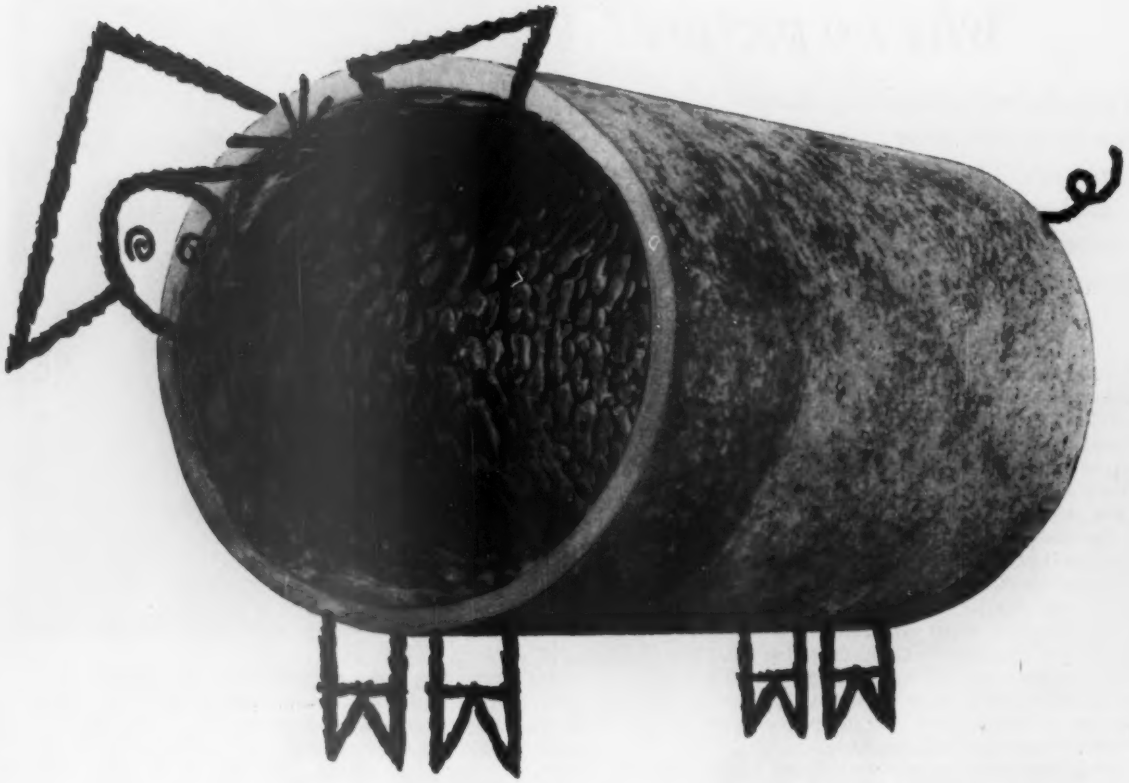
How can I dodge the pitfalls of "trial and error?" Go to a company that has no axe to grind . . . a company with the widest experience in water works problems. We, for instance, supply seven different kinds of pipe for water and sewage works . . . with fittings and valves to match. And we've always supplied the industry with a high percentage of the precision hard rubber water meter parts, rubber-lined ion-exchange tanks, molded chlorinator parts, rubber-lined intake lines, and chemical pumps now in use. For truly unbiased advice . . . backed by 100 years of experience . . . and prices as low as you'll find anywhere . . . come to American Hard Rubber Company.

Free Selector Charts. 20 valuable pages . . . comparable properties, chemical resistance, costs, etc., of 11 plastics and rubber materials. **Write today for Technical Bulletin CE-50W.**

Ace-Ite®, Ace Riviclor® and Ace Supplex® are approved for drinking water.

ACE RUBBER & PLASTICS EQUIPMENT
BY AMERICAN HARD RUBBER COMPANY
DIVISION OF AMERACE CORPORATION
ACE ROAD • BUTLER, N. J.

portrait of a power hog



When water flow capacities go down and pumping costs go up, the culprit is usually *tuberculation*. The way to deal with this power hog is right on his own ground — the inner surface of the water main. Here Calgon,® the simple and inexpensive way to deal with corrosion,† goes to work. By interposing a tough film between the metal surface and water, Calgon definitely controls corrosion.

Calgon treatment of the water is particularly effective after mechanical main cleaning because of its fast film-forming ability. Protection for freshly scored metal surfaces is quickly built up and easily maintained. Calgon treatment is as inexpensive as it is effective — a few ppm control tuberculation and other corrosion problems as well.

A letter or phone call will bring you more information on how Calgon can help. Or, an experienced Calgon engineer will be glad to make detailed recommendations on your specific problem.

CALGON COMPANY

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

†Fully licensed under U.S. Patent 2337856

FOR VOLUME METERING

SPARLING
WATERWORKS INTAKE METER

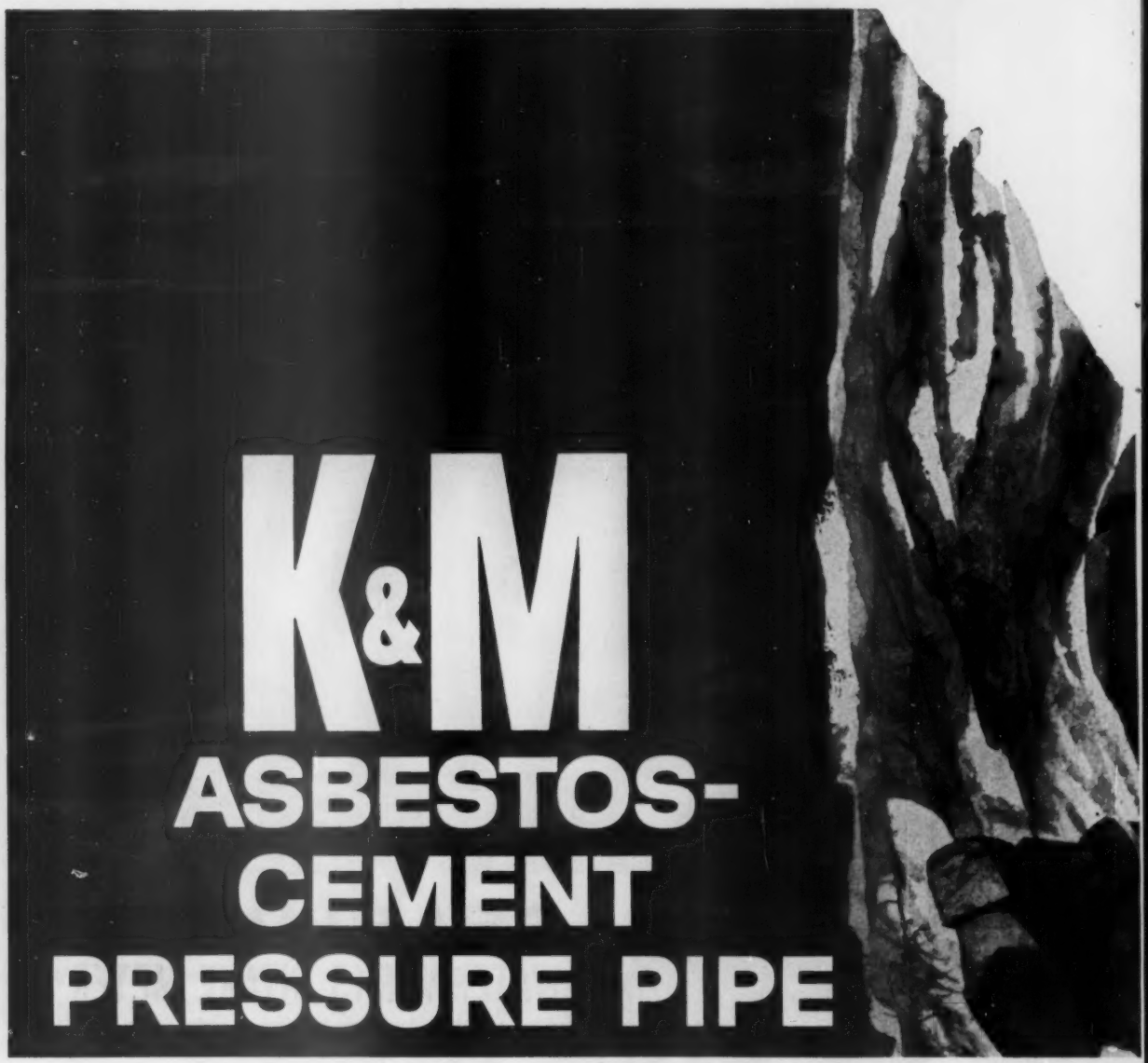
Wherever there are large volumes of water to be measured, this versatile meter provides greater control, increased efficiency and the opportunity for more exacting chemical feed. It accurately totalizes flows through closed conduits, inverted syphons, into reservoirs, and at many otherwise unmeasurable points. Negligible head loss makes it ideal for gravity flow systems. Installation is simple. Most perpendicular headwalls or similar structures are suitable, and the meter may be installed, removed, or inspected without interrupting service. Currently used in lines as large as 19' in diameter and can be utilized for even larger sizes.

Call your Sparling representative for complete details, or write for bulletin CF-239-1

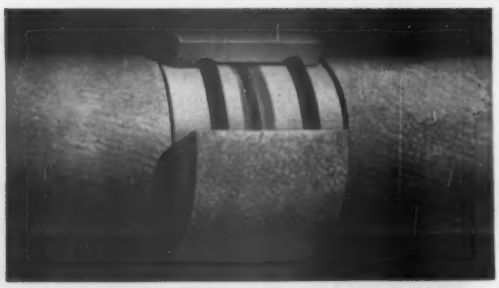
SPARLING
WATER CONTROL EQUIPMENT

SPARLING METER COMPANY *225 N. Temple City Blvd., El Monte, California*

Atlanta 3 • Chicago 4 • Cleveland 13 • Dallas 1, Tex. • Denver 6 • Kansas City 6, Mo. • Roselle, N. J. • San Francisco 24 • Seattle 99 • Romford, England
United Kingdom Affiliate: TYLORS OF LONDON LTD.



its bore stays clean year after year



The finest coupling in the industry! Exclusive patented "K&M" FLUID-TITE Coupling connects in two easy steps. Seals tight and stays tight . . . no matter how high the pressure climbs. Sealing rings are self-energizing. No cumbersome coupling puller is required. And, a 5° deflection per coupling if you need it.

"K&M" Asbestos-Cement Pressure Pipe is as *modern* as the Jet Age in which we live. This tax-saver sends maintenance costs tumbling.

The bore remains smooth and clean . . . no clogging and no rusty discoloration of water . . . and pumping costs remain low. Being made of tough, high-tensile-strength asbestos fibers and portland cement, "K&M" Asbestos-Cement Pressure Pipe is practically indestructible. Won't corrode or tuberculate. And, it's completely immune to electrolysis. Joints are permanently, automatically root-tight and water-tight.

for uninterrupted, trouble-free service

"K&M" Asbestos-Cement Pressure Pipe is a thrifty pipe. Its low initial cost is often your last cost. Its lightweight reduces shipping and handling costs.

This thrift carries over into installation. You can install "K&M" Asbestos-Cement Pressure Pipe in practically all kinds of weather and soil conditions . . . with unskilled labor . . . and without heavy machinery. In fact, you can lay more pipe per hour than you've ever done before.

What makes "K&M" Asbestos-Cement Pressure Pipe so special? Eighty-five years of asbestos engineering by one of America's pioneers in asbestos products. Put this wealth of experience to work for you. Write to us today.

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

Wedge-Lock®

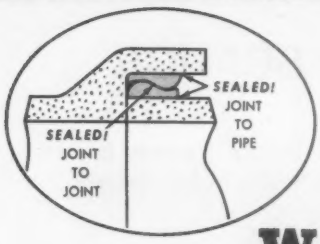
THE JOINT
with the

Full Circle
OF
PROTECTION

MINIMUM INFILTRATION!

ROOT-TIGHT SEAL!

FAST INSTALLATION!



When you install Vitrified Clay Pipe with Wedge-Lock Factory-Made Joints, you leave nothing to chance. Wedge-Lock pre-cast Joints are bonded to bell and spigot . . . snap together instantly . . . seal the entire circumference of the pipe to reduce infiltration and resist roots. Always specify Wedge-Lock, your Full Circle of Protection against infiltration . . . root problems . . . job delays . . . ultimate high cost resulting from costly repairs or maintenance.

Write to listed manufacturers for literature or an actual Wedge-Lock demonstration

Wedge-Lock CLAY PIPE

THE FACTORY-JOINTED CLAY PIPE AVAILABLE NATIONALLY FROM LOCAL MANUFACTURERS

Order Wedge-Lock from any of these Vitrified Clay Pipe Manufacturers:

Cannelton Sewer Pipe Company..Cannelton, Ind.
The Clay City Pipe Company....Uhrichsville, Ohio
The Evans Pipe Company.....Uhrichsville, Ohio
Graff-Kittanning Clay Products..Worthington, Pa.
Larson Clay Pipe Company.....Detroit, Mich.
The Logan Clay Products Company..Logan, Ohio
The Robinson Clay Product Co......Akron, Ohio
The Stillwater Clay Products Co...Cleveland, Ohio
Superior Clay Corporation.....Uhrichsville, Ohio

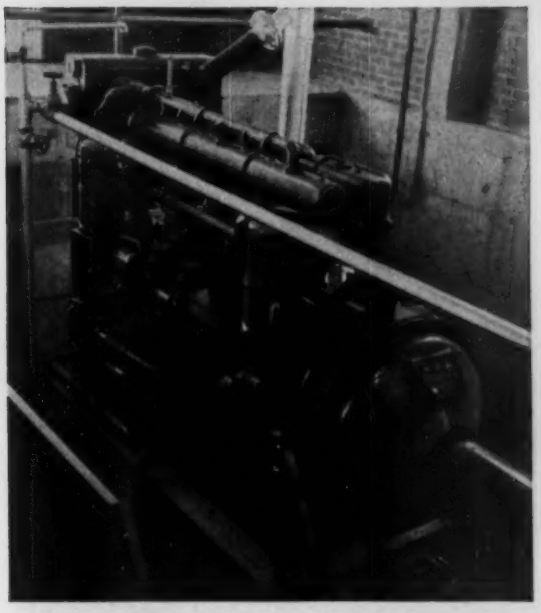
WLC-159-169-A

ROILINE ENGINES (Formerly LE ROI)

* The trade mark LE ROI is used under license from Westinghouse Airbrake Co., the trade mark owner.

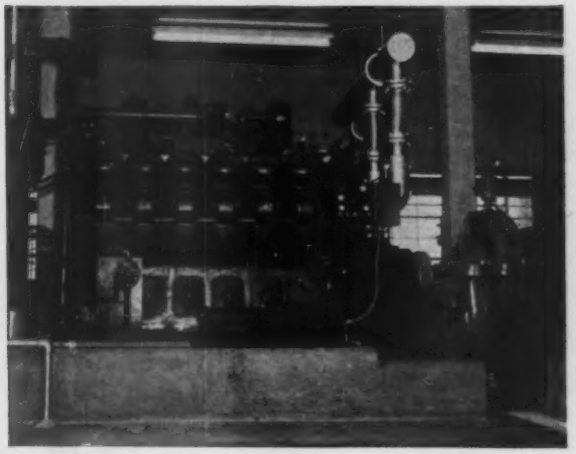
POWER FOR MUNICIPAL PLANTS

Three ROILINES pull the pumps at Oklahoma City's Lake Hefner Municipal Filtration Plant.



Model F-1500, maximum horsepower 215 at 1200 rpm on natural gas.

Model L-3460, maximum horsepower 595 at 1350 rpm on natural gas.



BASIC ENGINE CHARACTERISTICS*

GASOLINE OR NATURAL GAS					600	800	1000	1200	1400	1600	1800	2000	2200	2400
MODEL	Bore & S.	Cyls.	Displ.	Torque–rpm	BRAKE HORSEPOWER AT ENGINE SPEEDS INDICATED									
H540	4½ x 4¼	8	540	430- 900	...	64	82	99	115	130	143	155	164	170
H844	5¼ x 4⅞	8	844	637-1500	...	106	135	165	191	215	237	255	270	278
F1500	6¾ x 7	6	1503	1090- 650	125	165	200	215						
H2000	6¾ x 7	8	2004	1485- 650	170	225	270	290						
L3000	6¾ x 7	12	3006	2200- 650	250	335	405	435						
L3460	7¼ x 7	12	3468	2570- 900	285	391	492	568	595 @ 1350 RPM					
L4000	7.54 x 7.5	12	4000	2930- 900	325	446	560	645						

*With oil pump, water pump, magneto, air cleaner, carburetor, and exhaust muffler. Hp shown is maximum.

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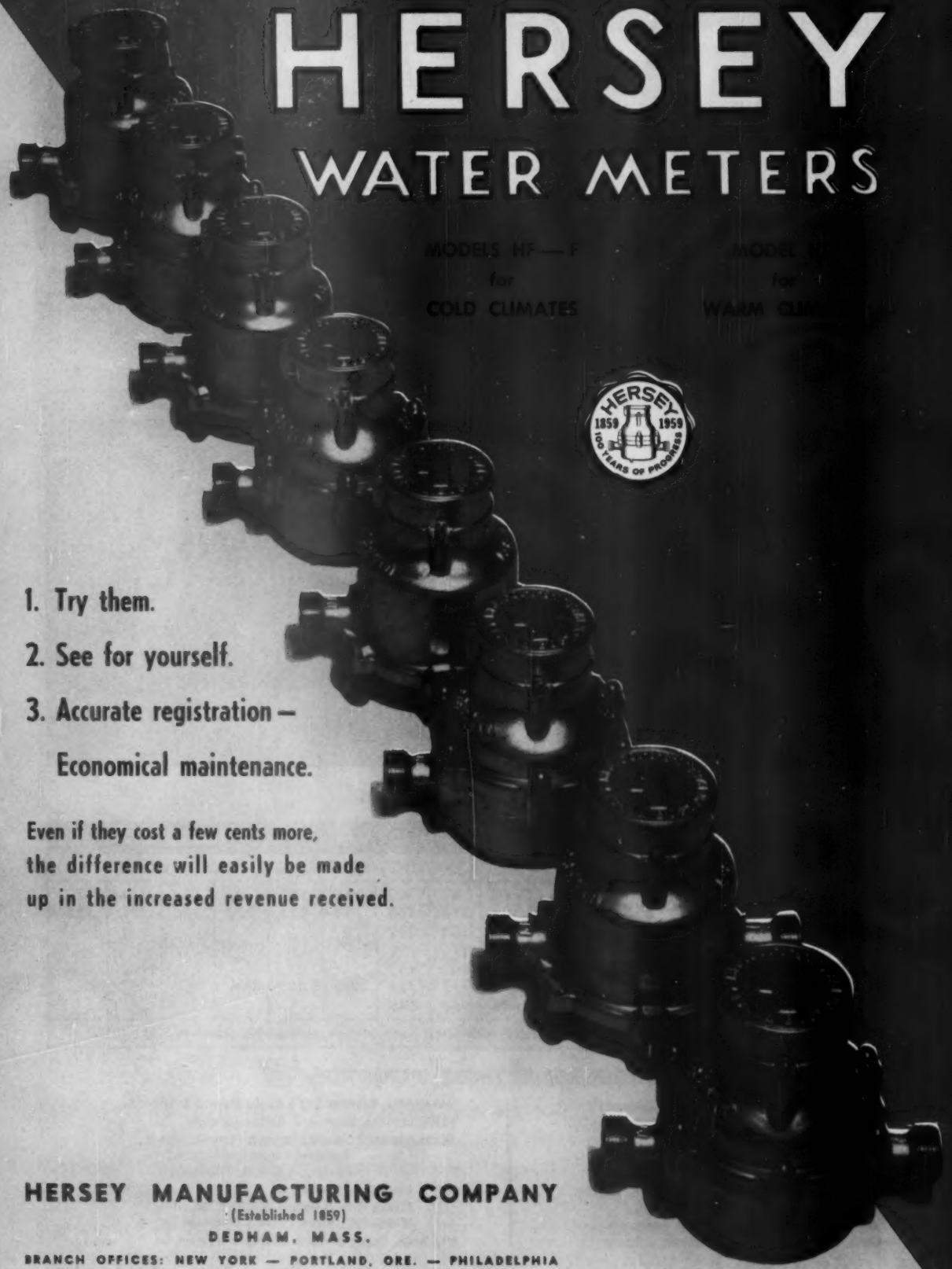
COLD CLIMATES

MODEL
for
WARM CLIMATES



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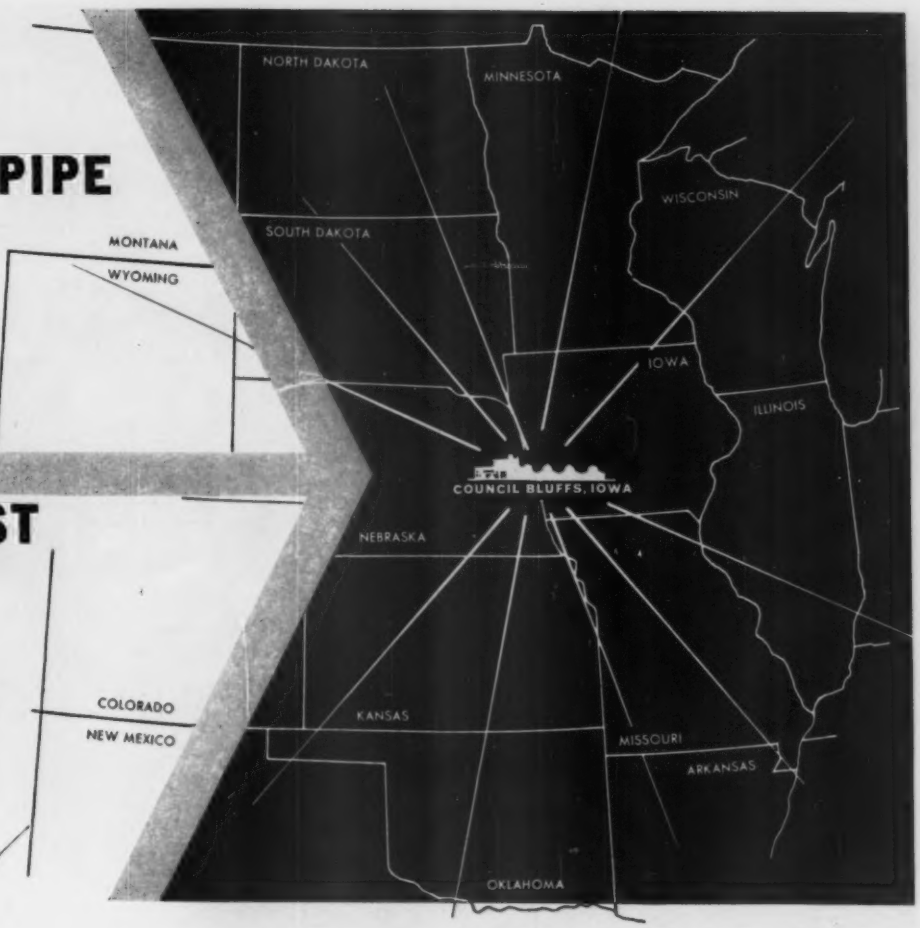
GRIFFIN PIPE SERVES THE ENTIRE MID-WEST FROM COUNCIL BLUFFS



Never before have cast iron pressure pipe users in the Plains States had such a strategically-located source for their pipe needs!

Because Council Bluffs is the transportation hub and heart of this vast area . . . and because the Griffin Pipe plant is served by *nine railroads* alone, in addition to *truck carriers* delivering pipe alongside trench . . . your pipe shipments will reach their destination in record time! This means time and money savings for you. *Also eliminates the need to maintain a large inventory.*

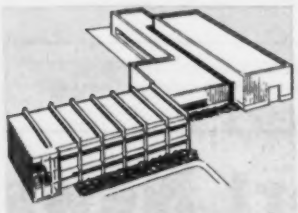
The newly-remodeled Griffin Pipe plant on the Council Bluffs site is the logical source for cast iron pressure pipe users in Missouri, Minnesota, Wisconsin, Illinois, Iowa, Kansas, Nebraska, North Dakota, South Dakota, Oklahoma, and neighboring states.

Griffin is the first American foundry to manufacture cast iron pressure pipe in modern 20-foot lengths, cast by the Delavaud process in the popular 4"-12" diameter size range. The 20-foot length means *10% fewer joints*, with consequent reductions in installation costs.

A complete selection of pipe joints is offered, including patented Bell-Tite *slip-on*, *mechanical joint*, and *bell and plain end*. **Griffin-20*** cast iron pressure pipe will be manufactured in accordance with ASA, AWWA, and Federal Specifications for water and gas distribution.

Take advantage of the strategic location of this new plant . . . and the substantial economies it can effect in *your* pipe installations!

*"Griffin-20" is a trademark of Griffin Wheel Company



Griffin is constructing a new million-dollar pipe research center in Bensenville, Illinois. Griffin founded in 1879, has 11 plants, and has poured more than 15 million tons of iron.

GRIFFIN PIPE
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GRIFFIN WHEEL COMPANY
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GRIFFIN PIPE DIVISION
COUNCIL BLUFFS

Newport News rack rakes . . . minimum-manpower way to keep water intakes free of debris

Newport News mechanical rack rakes are power-operated rakes for cleaning trash racks at water intakes, including those at hydro-electric plants, steam plants, pumping stations, and similar installations throughout this country and abroad. Under ordinary conditions, one man per shift keeps racks clean for a dozen bays.

Operate in channel guides for maximum cleaning action

A Newport News rake *won't ride over trash* nor will its teeth drop the debris, because the rake operates in channel guides for positive action. Special teeth are available for cleaning racks of filamentous algae, seaweed, etc.

The Newport News mechanical rack rake has been built to operate in bays from 5 feet 6 inches wide to 28 feet 6 inches in width. Forebay design determines the maximum width for a single rake. In the case of a very wide bay, intermediate guides are sometimes used to reduce the length of the rake. There are many typical installation arrangements to fit your needs. Newport News engineers are prepared to individualize these designs for you.

If you have a debris problem, write for a copy of THE NEWPORT NEWS MECHANICAL RACK RAKE, an illustrated booklet describing the installation, operation, and advantages of a Newport News rake.

Engineers . . . Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

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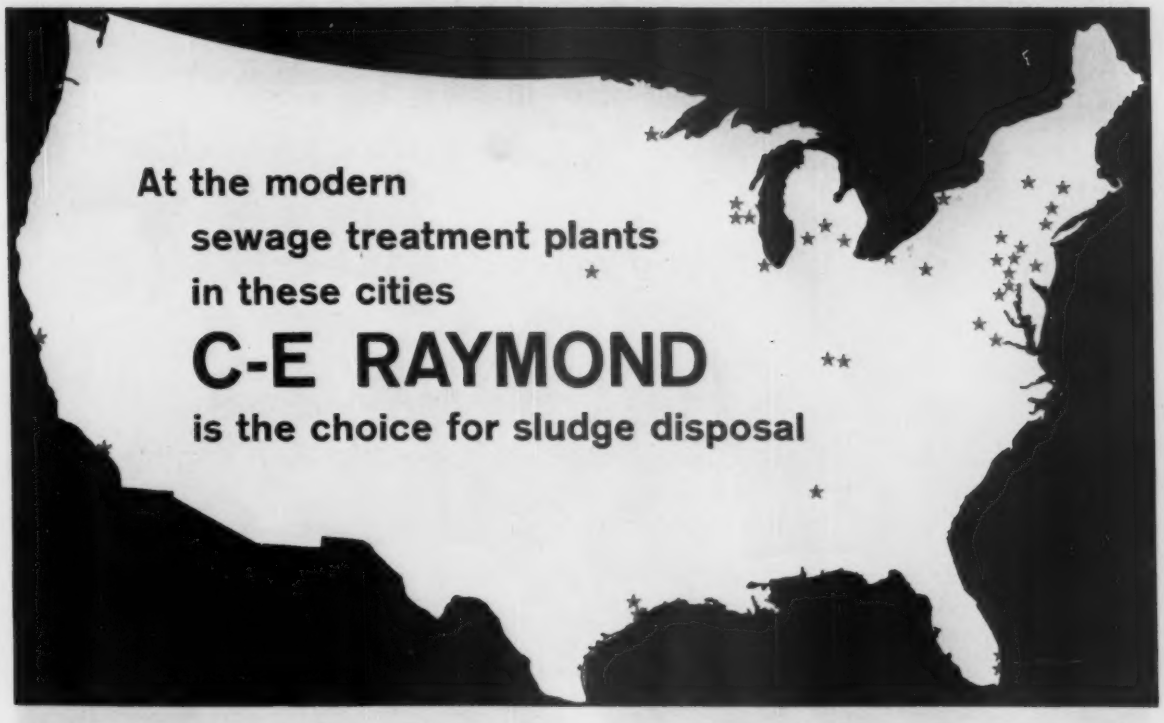

Here are some reasons why the C-E Raymond Flash Drying and Incineration System has been selected by treatment plants throughout the country . . .

Flexible – It reduces filter cake to non-lumpy particles of uniform low moisture content without scorching . . . a product very suitable for use as soil conditioner . . . or if sludge characteristics render it unfit for this use, quickly incinerates it to a sterile ash. It is available with high temperature deodorization and fly ash collection.

Efficient – It assures built-in plus-performance for effective and controlled drying of filter cake with high *thermal* efficiency. This means less fuel cost penalty when incinerating low heat-content sludges since design thermal efficiency can be consistently maintained.

Advanced – It incorporates small groups of arch bricks individually hung from steel supports rather than relying upon self-supporting refractory arches. This requires little maintenance, makes arch failure virtually impossible, and permits rapid start-ups . . . less than 30 minutes for furnaces capable of burning in excess of 120 tons of filter cake daily. It has the most fully automatic controls for drying and furnace operation of any system available.

Proven – It is the most widely used method for heat disposal of sewage sludge. More filter cake is dried and/or incinerated in the C-E Raymond System than in all other systems combined.

For further details contact the Combustion Engineering office nearest you. Our engineers will be happy to discuss, with you or your consultants, how this system can benefit your community.

★ **Communities in the United States which have selected C-E Raymond for sewage sludge disposal**

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Cuyahoga Falls, Ohio
Duluth, Minn.
Fond du Lac, Wisc.
Galveston, Texas
Harrisburg, Pa.
Houston, Texas
Jefferson Co., Ala.
Lansing, Mich.
Los Angeles, Calif.
Louisville, Ky.
Lynchburg, Va.
Miami, Fla.
Neenah-Menasha, Wisc.
New Albany, Ind.
New Rochelle, N. Y.
Omaha, Neb.
Petersburg, Va.
Pittsburgh, Pa.
San Francisco, Calif.
Schenectady, N. Y.
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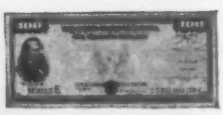

WATER & SEWAGE WORKS

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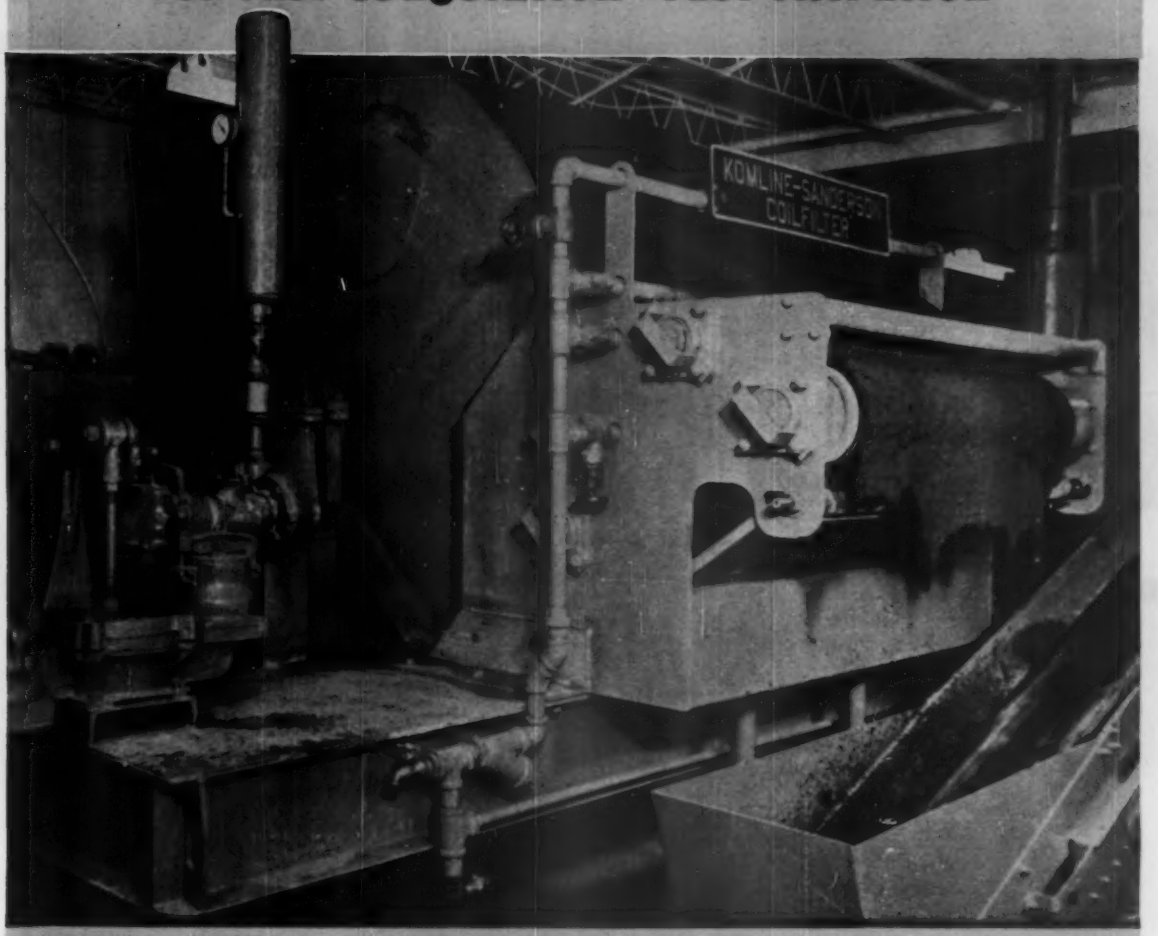
for fast coagulation—fast filtration



Pennsalt Ferric Chloride helps you cash in on the important space and operating economies of vacuum sewage filtration. Ferric chloride gives you fast, thorough coagulation . . . drier, denser filter cake . . . higher output per square foot of filter area.

Vacuum equipment takes far less space than drying beds. Automatic separation of sludge from the vacuum drums eliminates manual removal . . . lowers daily operating costs.

Pennsalt has helped apply ferric chloride to waste treatment for over 30 years. Whether you are considering modernizing your present plant or designing new facilities write or call Pennsalt for full information on handling and using ferric chloride.

For dependable water treatment use Pennsalt Water Works Grade Chlorine.

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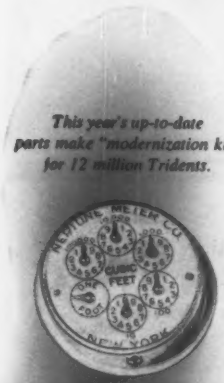
Do you have AUTOMATIC MODERNIZATION in your water system?



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No need to keep complicated stocks of parts for many models . . . just keep a small stock of modern parts. It's easier to train service men, too. Your men need learn only one simple, fool-proof model, and they can service all.

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Vol. 106, No. 11, November, 1959

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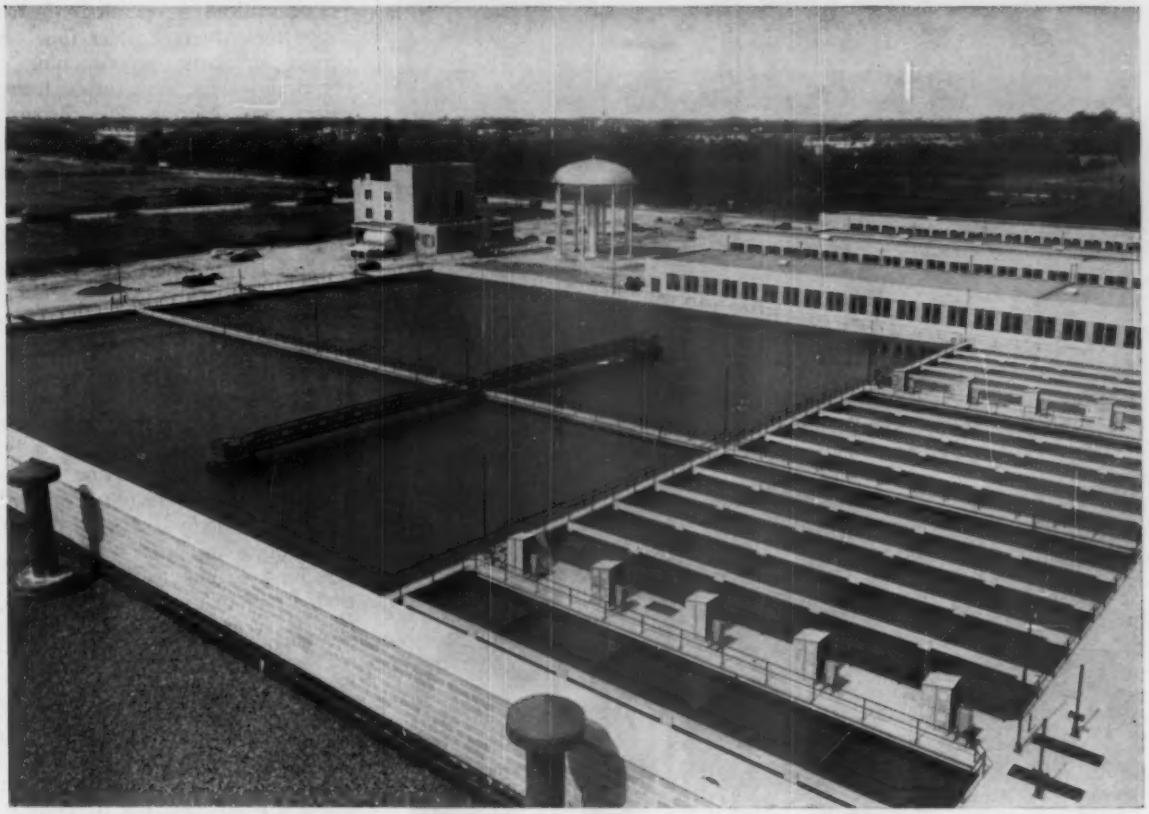
WATER & SEWAGE WORKS



Philadelphia's dream comes true with completion of

Torresdale, *the Push Button Plant*

A Staff Pictorial Report

RESUME: After a five-year construction program, completion and start-up of the new Torresdale plant fulfills Philadelphia's dream of a completely modern water system. This report illustrates some of the features of this push-button plant.

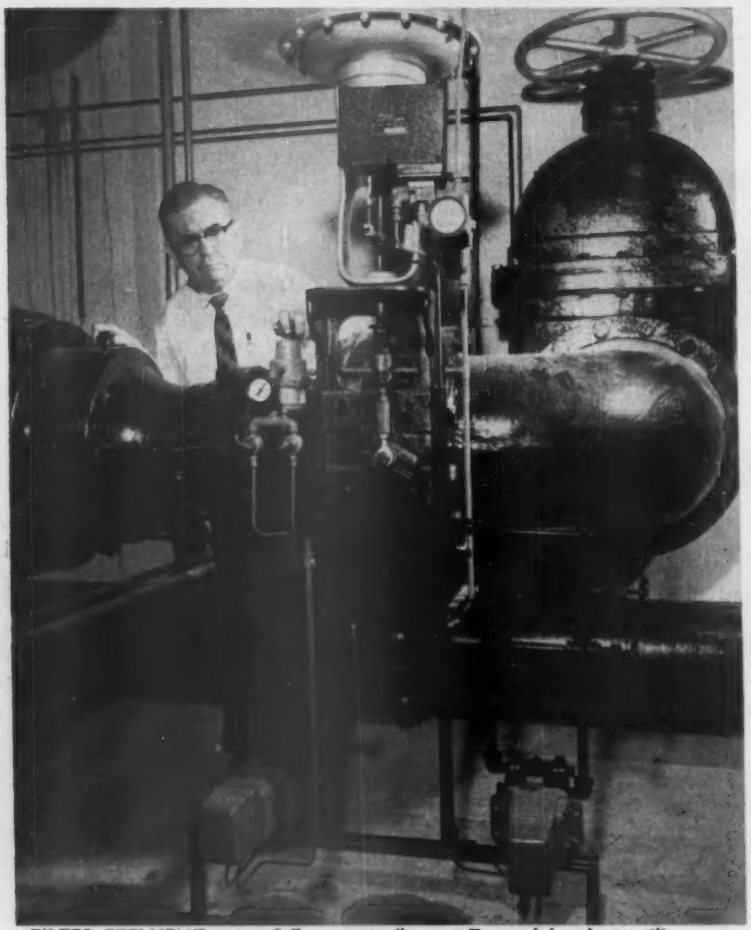
■ SINCE 1952 the Philadelphia Water Department has scheduled expenditures for improvements costing $123 million. These funds have been invested in treatment plants, pumping stations, water mains and control systems. Designed to treat 282 Mgd from the Delaware river, the new Torresdale plant cost $25 million.

Replacing the historic slow sand filter plant in an extensively automated array of advanced design equipment.

Torresdale was designed by Morris Knowles, Inc., Pittsburgh Consulting Engineers, and the architect was Philadelphia's Walter Antrim. A total of 36 contractors and sub-contractors contributed to the plant's construction on its 10 acre site. An interesting sidelight is the statistic that the filters alone, for the old slow sand filter plant occupied 60 acres.

The new plant consists of a preliminary treatment building for application of chemicals to the raw water, rapid mixing and slow mixing basins, four huge sedimentation basins, the four and one-half acre filter building, and a post treatment building for final application of chemicals. In addition there are laboratories, offices, wash water tanks, and related facilities.

WATER COMMISSIONER Samuel S. Baxter (L) and Deputy Commissioner Gerald Arnold examine a master filter control panel in the new plant.



FILTER EFFLUENT rate of flow controllers at Torresdale plant utilize venturi and pneumatically operated butterfly valve. Loss-of-head and rate-of-flow are converted to pneumatic for instrumentation.

Raw water, stored in a 176-million gallon earthen reservoir replenished twice-a-day during mean high tides, is pumped through twin conduits eight feet in diameter to pre-treatment chemical building where chemicals are added.

Pneumatically operated instruments measure raw water flow and permit automatic proportioning of chemicals—alum, lime, carbon if necessary, and chlorine. The chemicals are added by automatic weighing and feed machines as raw water enters eight rapid mixing basins beneath the pre-treatment building.

Other controls measure the liquid level of chemicals in storage tanks, tripping an alarm when pre-set high and low limits are reached; monitor alarm points to determine if pumps and exhausters on storage bins are functioning properly; and indicate, with lights, the operation of circulating pumps and other devices.

From the rapid mixing basins, where water and chemicals are agitated for 30 seconds, the water goes to 40 open air slow mixing chambers for a 45 minute flocculation period. Entry to the sedimentation basins is accomplished through portholes. The water is detained 2½ hours for settling and clarification. The 174-ft long clarifier arms are equipped with scrapers, making a complete revolution every hour. Sludge is swept into the middle of the basins from where it is pumped to a riverside lagoon. From the sedimentation basins the water enters the rapid sand filters in the main building.

Separate Gallery Control Panels

Each of the two filter galleries has its own control panel on which there are instruments that perform special chores.

On one panel, for example, an electronic potentiometer measures the rate-of-flow to the post-treatment building where the filtered water is re-chlorinated, fluorides added for dental caries control, and lime and metaphosphates injected to minimize corrosion in distribution mains.

A two-pen indicator-recorder integrates the 24-hr total wash water flow and the rate of flow from one of the two elevated storage tanks. Another indicator-recorder, with control elements, notes the level in the wash water storage tank and operates the pumps that fill it.

Surface wash water rate-of-flow is recorded and totalized on another indicator-recorder. Totaling the amount of both surface and backwash water used in relation to the amount of water filtered provides an index of the filtration system's efficiency.

A fifth instrument on the panel records the common water level in the mixing and sedimentation basins and in the rapid sand filters. Other controls, adjusted manually, automatically vary the amount of flow from wash water tanks depending upon the number of pumps in operation.

Together, the control panels for the two galleries act as a master control station. As the city's demand for water fluctuates, changing reservoir storage levels, two electronic level and one pneumatic flow controllers act as a unified system to increase or decrease flow rates from the rapid sand filters so that normal reservoir levels can be maintained.

OPERATING DETAILS of a filter console is explained to Commissioner Baxter by plant Supt. John Dillener.

Controls in the post-treatment chemical building automatically proportion the amount of chlorine, dry chemicals and fluorides added to the water. From the building the finished water flows through a 10-ft diameter main to a 50-million gallon underground clear water reservoir. When the slow sand filters of the old filtration plant are made available for storage, an integral control system, located in the main building on a separate panel, will alternately control the flow to and from these storage basins depending upon demand. During the day, when water needs are greatest, these basins will be called upon to supply the above-average demand. At night, when demand is lowest, filtered water will be fed into these basins.

Filter equipment and piping, as well as the substructures and superstructures, of the filter building and basins were the work of McCloskey and Company, at a cost of approximately $10 million. The Conduit and Foundation Company constructed two 8-ft diameter conduits, 3,000 ft in length ($1.6 million), while Hughes-Foulkrod Company built the preliminary and post treatment buildings, plus a 10-ft diameter conduit, at a cost of $5.3 million.

The extensive system of automatic and semi-automatic controls ($0.5 million) was designed and installed by the Brown Instrument Div., Minneapolis-Honeywell Regulator Co., of Philadelphia.

MODERN WELL-LIGHTED filter operating galleries are featured in the plant. Consoles permit local operation and backwashing of each filter.

Sample testing, water analysis, and fallout studies provide a comprehensive report on . . .

Radioactivity In Surface Waters

RADIOACTIVITY IN SURFACE WATERS OF THE UNITED STATES by Dr. Lloyd R. Setter, Chief of Radiological Investigations for the Robert A. Taft Sanitary Engineering Center, Report on radioactivity measurements on samples of surface water. These measurements were made on weekly samples from 44 stations in major U.S. river basins. The report covered an 11-month period ending Sptember 30, 1958. Insignificant increases in beta activity over normal background occurred in the first five months; however, there was a marked increase in beta activity during the last six months of the test period. This increase corresponds to the more intense period of atomic weapons testing in the spring and summer of 1958. Alpha activity in excess of background was negligible. Beta activity was correlated with suspended solids. Impounded waters exhibited relatively low levels of suspended matter activity which is indicative of removal by sedimentation. Only a small portion of the radioactivity carried down by rain in the Central Plains area appears in river water. This indicates that the greater proportion of rainout remains in the soil and on crops. Further studies will be conducted.

RADIOACTIVITY IN LAKE MICHIGAN by H. H. Gerstein and J. C. Vaughn. A discussion of radioactivity in Lake Michigan water at the Chicago intakes. Chicago was one of the first cities to start a radioactivity monitoring program. Tests were begun in 1950 and the program has been continued to the present time. The testing procedure has been modified and expanded as necessary over the past nine years. Annual average gross radioactivity of the raw lake water was 6.65 micro-micro curies per liter in 1956; 12.22 in 1957, 7.46 in 1958 and 14.1 for the first five months of 1959. The increased in radioactivity in the lake water supply conform generally to the timing of nuclear bomb tests conducted in various parts of the world. Average removal of radioactivity of approximately 40% was accomplished by the routine operation of the South District Filtration Plant. Tests on rainfall samples showed that the change in radioactivity in these samples roughly paralleled the increases and decreases in the lake water. The apparent half-life of the radioactivity in the rain water has increased from about six days in October 1958 to three months during March and April, 1959. Filtration of samples of raw lake water and rain water through membrane filters showed about the same percentage of removal of radioactivity as by the conventional water filtration process. This indicates that removal of activity is limited to particular material.

RADIOACTIVITY SAMPLE-TESTING PROGRAM by Harold E. Pearson, Research Chemist, Metropolitan Water District of Southern California. Experiences with a sampling-testing program started in 1951. The program included radioactivity tests on soil as well as water samples. The maximum increase in activity occurred in soils along the aqueduct. Water treatment has reduced activity from 18 to 75%. Treatment could be altered, if necessary, to provide up to 90 to 98% removal of radioactivity. Pearson emphasized the importance of checking soil and rainfall as well as surface water.

RADIOACTIVE FALLOUT by Harry Kramer of the Robert Taft Sanitary Engineering Center. Reported that fallout is currently the principal source of radioactivity. Fallout varies extensively with time and geographical location. Only a small fraction of fallout reaches surface waters. Factors tending to reduce activity levels in surface waters are time of flow, sorption on suspended matter, and water treatment. Kramer emphasized that data on the ingestion of radioactive materials derived from water must be correlated with the intake from other sources.

WATER ANALYSIS BY NEUTRON ACTIVATION by Harry Kramer of the Robert A. Taft Sanitary Engineering Center. An informative discussion about a sensitive new method of water analysis. The basis of the method is induced radioactivity which is accomplished by neutron bombardment of chemical elements present in the water. Many elements when subjected to bombardment by neutrons yield radioactive species of the same element. The nature and amount of radioactivity induced by neutron bombardment can be determined. This forms the basis of a technique called "neutron activation analysis". The method is extremely sensitive and applicable to a large number of the chemical elements.

A fundamental discussion of an item of basic interest . . .

Flow Resistance in Pipes and Fittings

by DONALD R. F. Harleman
Assoc. Prof. of Hydraulics
Massachusetts Institute of Technology
Cambridge, Mass.

AUTHOR'S NOTE: To a water works engineer the term "loss of head" is as familiar and commonplace as any he encounters in his everyday work. Unfortunately it is at the same time a concept which has been so submerged in a variety of empirical formulas that its relation to physical reality has been forgotten or never fully understood by many. The purpose of this article is not to review the long history of empiricism in the calculation of head loss or to discuss the merits of one formula over another, because only a very few of the purely empirical formulae survive in practice. Neither is it intended to advocate the complete abandonment of those which survive or to suggest that their use is restricted to the unenlightened. Nevertheless it is important that such formulae be used within their range of validity and that their use be coupled with an understanding of the physical mechanism of fluid resistance. It is the purpose of this article to review the general problem of flow resistance in pipes and fittings and to provide a frame of reference whereby the sanitary engineer is capable of intelligently handling situations outside of his everyday experience.

Introduction

■ A RATIONAL APPROACH to the analysis of fluid flow must begin with a definite characterization of the flow under consideration. Such characterization must include a description of the boundaries confining the fluid, and the possible variation of fluid properties and fluid velocities. By implication the title of the article restricts the discussion to flows which are entirely confined by solid boundaries thus excluding free surface or open channel problems. With regard to variation of fluid properties, the discussion will be concerned with incompressible fluids in which the fluid density and specific weight is a constant and in which the viscosity depends only on the fluid temperature. In respect to velocity variations, four possible types of flow exist, namely: unsteady-non uniform, unsteady-uniform, steady-non uniform and steady-uniform. The terms, steady and unsteady, refer to the possibility that at a fixed point the velocity may vary with time. Hence in a steady flow the velocity at a given point is constant. The terms uniform and non-uniform refer to a possible variation in velocity between two points in the flow. Between any two sections of a conduit of constant cross-section, the flow with respect to the mean velocity is regarded as uniform. Likewise the flow between two points separated by a valve is said to be non-uniform. In practice water distribution systems are almost invariably in a state of unsteadiness due to variation of demand with time. However, it is usual to base designs on certain peak flows which are regarded as being steady. This article will be concerned only with steady flows both uniform and non-uniform. In summary the discussion will treat the steady flow of an incompressible fluid in an enclosed system.

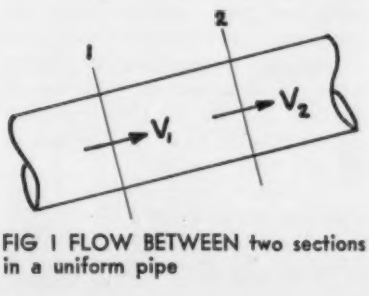


FIG 1 FLOW BETWEEN two sections in a uniform pipe

Resistance in Uniform Pipes

The Mechanism of Fluid Resistance

The case of flow in a pipe line of constant cross-sectional area will be treated initially. Consider, as in Fig 1 the flow between sections 1 and 2; at each section the area, mean velocity and fluid density will be designated by A, V, ρ respectively. The product of area and mean velocity is a discharge, Q=AV, having the dimensions of volume of fluid flowing per unit time or cubic feet per second. Density, ρ, is a measure of the mass of fluid per unit volume, hence the product ρAV or ρQ expresses the total mass of fluid flowing past a certain section in one second, (i.e. mass per second. The law of conservation of mass must hold between any two sections in a continuous flow. This is simply a statement of the fact that mass is neither created nor destroyed between the sections under consideration. With respect to Fig 1 this means that the mass of fluid crossing section 1 in one second equals the mass of fluid crossing section 2 in one second, thus we have the equation of continuity:

$$\rho_1 A_1 V_1 = \rho_2 A_2 V_2$$

Since we are dealing with the flow of an incompressible fluid in a constant area conduit it follows that $\rho_1=\rho_2$ and $A_1=A_2$ and therefore we have proved that, from equation [1], $V_1=V_2$. This shows that irregardless of the resistance which the fluid encounters in a pipe, the mean velocity cannot change unless the area chang-

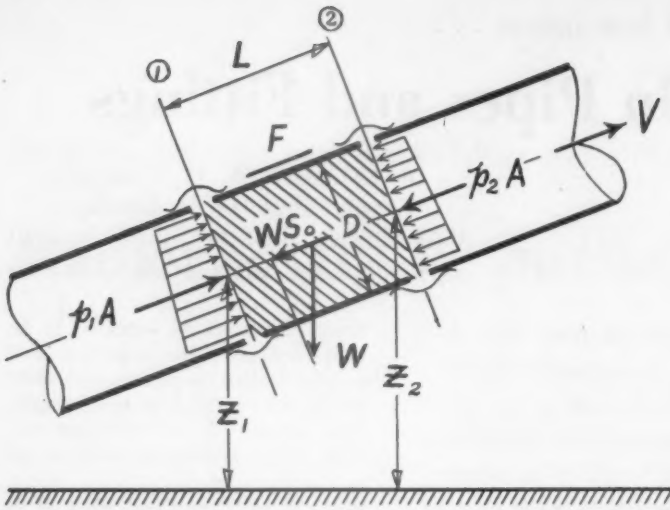


FIG 2 FORCES ACTING on the fluid between two cuts in a uniform pipe

es. Therefore the flow shown in Fig 1 is uniform.

The second law which the fluid must obey corresponds to the statement that the total force exerted on a moving body is equal to the product of the mass of the body and its acceleration. Since, in Fig 1, the velocity is constant both in time and along the pipe, the acceleration of the fluid is zero. The second law therefore reduces to the simple statement that the total force exerted on the fluid between sections 1 and 2 must equal zero. Fig 2 shows a pipe which has been cut at sections 1 and 2, it will be assumed that leakage is prevented by flexible rubber gaskets at these sections. It is now possible to imagine the forces acting on the fluid contained in the shaded portion between the cuts:

1. The mean pressures at the cross-sections 1 and 2 are p_1 and p_2 and the corresponding forces exerted on the fluid by these pressures are p_1A and p_2A.
2. The fluid contained within the shaded portion has a total weight W and the component of the weight in the direction of flow is WS_0 where $S_0=\frac{Z_2-Z_1}{L}$. (Note that the component WS_0 becomes zero when the pipe is horizontal and $Z_2=Z_1$).
3. The moving fluid exerts a frictional resistance force upon the stationary wall of the pipe which would tend to move the cut portion to the right thereby stretching the gasket at section 1. In order to return the pipe to its original position it would be necessary to apply an equal and opposite force F directed to the left as shown in Fig 2.

The total force exerted on the fluid is obtained by adding the three contributions described above, taking positive forces in the direction of flow and observing that the total force must be zero:

$$p_1A - p_2A - WS_o - F = 0$$

If the weight of fluid per unit volume is γ, the total weight of the fluid in thesection is,

$$W = \gamma AL$$

since the product AL represents the volume of the fluid.

Therefore equation [2] becomes,

$$p_1A - p_2A - \gamma ALS_o = F$$

and if each term is divided by the product γA,

$$\frac{p_1}{\gamma} - \frac{p_2}{\gamma} - LS_o = \frac{F}{\gamma A}$$

but since $S_0=\frac{Z_2-Z_1}{L}$ we have,

$$\frac{p_1}{\gamma} - \frac{p_2}{\gamma} - Z_2 + Z_1 = \frac{F}{\gamma A}$$

For uniform flow in a pipe of diameter D, "head loss" shown in Fig 3 is defined as the change in the sum of the pressure and elevation heads between two sections a distance L apart, thus:

$$\left(\frac{p_1}{\gamma} + Z_1\right) - \left(\frac{p_2}{\gamma} + Z_2\right) = \text{head loss} = h_L$$

By comparing equations [3] and [4] it is easily seen that,

$$h_L = \frac{F}{\gamma A}$$

or since $A=\pi D^2/4$,

$$h_L = \frac{4F}{\gamma \pi D^2}$$

In fluid mechanics it is customary to express the frictional drag force F in terms of a dimensionless resistance coefficient c_f, the fluid density ρ, mean velocity V, and the area over which the frictional force is applied:

$$F = c_f \frac{\rho V^2}{2} (\text{Area})$$

since the area over which the frictional force is applied is the perimeter of the circle times its length,

$$(\text{Area}) = \pi DL$$

$$F = c_f \rho \frac{V^2}{2} \pi DL = c_f \frac{\gamma V^2}{2g} \pi DL$$

since $\rho=\frac{\gamma}{g}$ where g is the acceleration of gravity, g=32.2 ft/sec.^{2} Equation [5] can then be written,

$$h_L = 4\, c_f \frac{\gamma V^2}{2g} \frac{\pi DL}{\gamma \pi D^2} = 4\, c_f \frac{L}{D} \frac{V^2}{2g}$$

for convenience, in pipes, the resistance coefficient $f=4\ c_f$ and

$$h_L = f \frac{L}{d} \frac{V^2}{2g}$$

Equation [7] is known as the Darcy-Weisbach equation and is applicable to the flow of any incompressible liquid in a circular pipe. There is no question about the validity of the equation and its use in determining the head loss in actual problems depends only on a knowledge of how the resistance coefficient, f, depends on the flow characteristics and the condition of the pipe wall. In turbulent flow, which is the only kind encountered in water supply practice, this relation cannot be found theoretically and recourse must be made to experimental results.

Experiments on Pipe Resistance

The collection of experimental data on the flow of liquids in pipes has a long history. Perhaps one of the earliest systematic sets of observations was by Darcy (1857). There involved 22 conduits of wrought iron, lead, cast iron, asphalted iron and glass, varying in diameter from about ½ inch to 18 inches and in various states of deterioration. Worthy of mention also are the pipe resistance experiments of John R. Freeman in the late 19th Century.

The modern understanding of pipe resistance began about 1930 with the Prandtl-Karman theory which was supported by the experiments of

Nikuradse, Colebrook and White.

Qualitatively, the conclusions of the experiments in turbulent flow may be summarized as follows:

1. The head loss varies *directly* as the length of the pipe L. This conclusion is expressed *exactly* by equation [7], hence f must be *independent* of L.
2. The head loss varies *almost* as the square of the velocity. Since the velocity appears as the square in equation [7], the friction factor f must change slightly with the velocity of flow.
3. The head loss varies *almost inversely* as the pipe diameter. The diameter appears in the denominator as the first power, hence, the friction factor must also change slightly with pipe diameter.
4. The head loss depends on the surface roughness of the interior pipe wall. The friction factor must therefore vary in some fashion with a measure of the mean roughness height, ϵ (FT.)
5. The head loss depends on the fluid viscosity ν (FT^2/sec).
6. The head loss is *independent* of the absolute pressure in the pipe; f is therefore *independent* of ρ.

Due to conclusion 2, 3, 4 and 5 the friction factor cannot be a constant for a given pipe, but must depend on the magnitudes of V, D, ϵ, ν. From equation [7] it is noted that f is a dimensionless number and therefore it must depend on certain combinations of V. D. ϵ, ν which can be grouped together into dimensionless numbers.

It is fairly simple to show that if V is measured in feet per second, D in feet and viscosity ν in square feet per second the combination VD/ν is a dimensionless number called the *Reynolds Number*. Likewise, since both D and ϵ are measured in feet the combination ϵ/D is the other dimensionless number called the *relative roughness*.

General Pipe Resistance Diagram

On the basis of a large number of experiments on resistance in commercial pipes Moody (1944) has obtained a series of curves on a single diagram which describe the relation between the friction factor, the relative roughness and the Reynolds number for all fluids and all pipes.

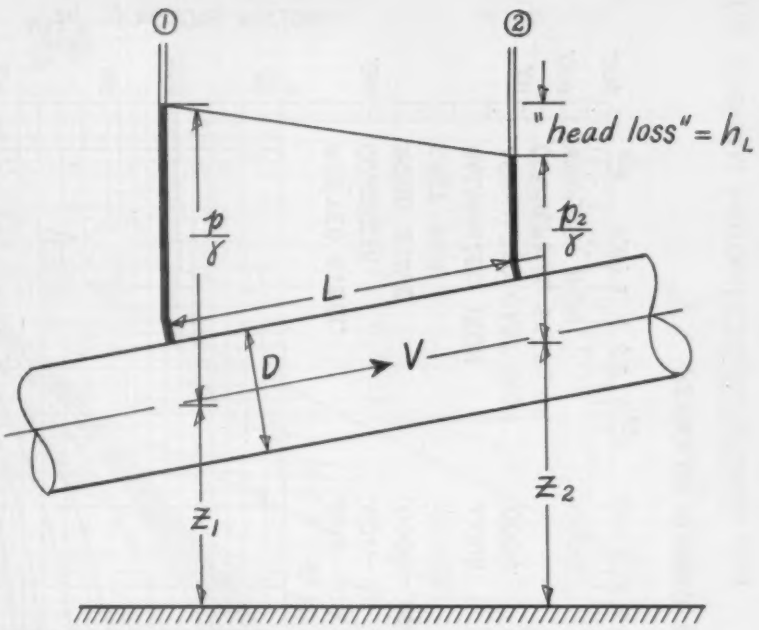


FIG 3 DEFINITION SKETCH for head loss in a uniform pipe

This diagram is reproduced as Fig. 4 and contains values of the friction factor along the left margin, the Reynolds number along the bottom and the values of ϵ/D corresponding to the heavy curves along the right margin. For water at 60°F the viscosity is a constant and the Reynolds number scale at the bottom may be replaced by an auxiliary scale at the top for the product of velocity in feet per second and pipe diameter in inches. Values of the mean roughness length ϵ in feet are given for typical new pipe materials in the table at the lower left of the diagram.

Example:

It is desired to find the head loss in 1000 ft of new 6 in. cast iron pipe (ϵ=.00085 ft.) for a flow of 1000 gpm of water.

$$\text{Area} = \frac{\pi(.5)^2}{4} = .196 \text{ FT}^2$$

$$\text{Discharge } Q = 1000 \text{ gpm or } \frac{1000}{449} = 2.23 \text{ cfs}$$

since 1 cfs = 449 gpm

$$\text{Velocity} = Q/A = \frac{2.23}{.196} = 11.4 \text{ ft/sec.}$$

hence, (velocity) x Dia. (inches) = (11.4) (6)=68

$$\text{The relative roughness is } \frac{\epsilon}{D} = \frac{0.00085}{0.5} = .0017$$

Using the top scale for VD=68 and interpolating between .002 and .001 on the family of ϵ/D curves for .0017 the value of f=.023 is read on the left hand scale.

The head loss is

$$h_L = f\frac{L}{D}\frac{V^2}{2g} = (.023)\ \frac{1000}{0.5}\ \frac{(11.4)^2}{64.4} = 93 \text{ ft.}$$

One of the most interesting features of the pipe resistance problem is shown by the fact that a given pipe becomes "hydraulically smoother" as the flow rate is decreased. Conversely it becomes "hydraulically rougher" as the flow rate is decreased. Conversely it becomes "hydraulically rougher" as the flow rate is increased. This is shown in Fig 4 if, for example, a pipe having a relative roughness $\epsilon/D = .001$ is considered. If the heavy curve for $\epsilon/D = .001$ is followed for decreased flow rates it is seen to merge with the smooth pipe curve for very low rates of flow. At a flow rate corresponding to $(VD^{11}) = 200$ the flow is completely indepenent of the Reynolds number and the friction factor is constant for all further increases in the discharge. The explanation lies in the fact that at low rates of flow a luminar (non-turbulent) film of fluid exists at the wall of the pipe. If this laminar layer is of sufficient thickness to cover the small roughness projections, the pipe has a friction factor the same as that of

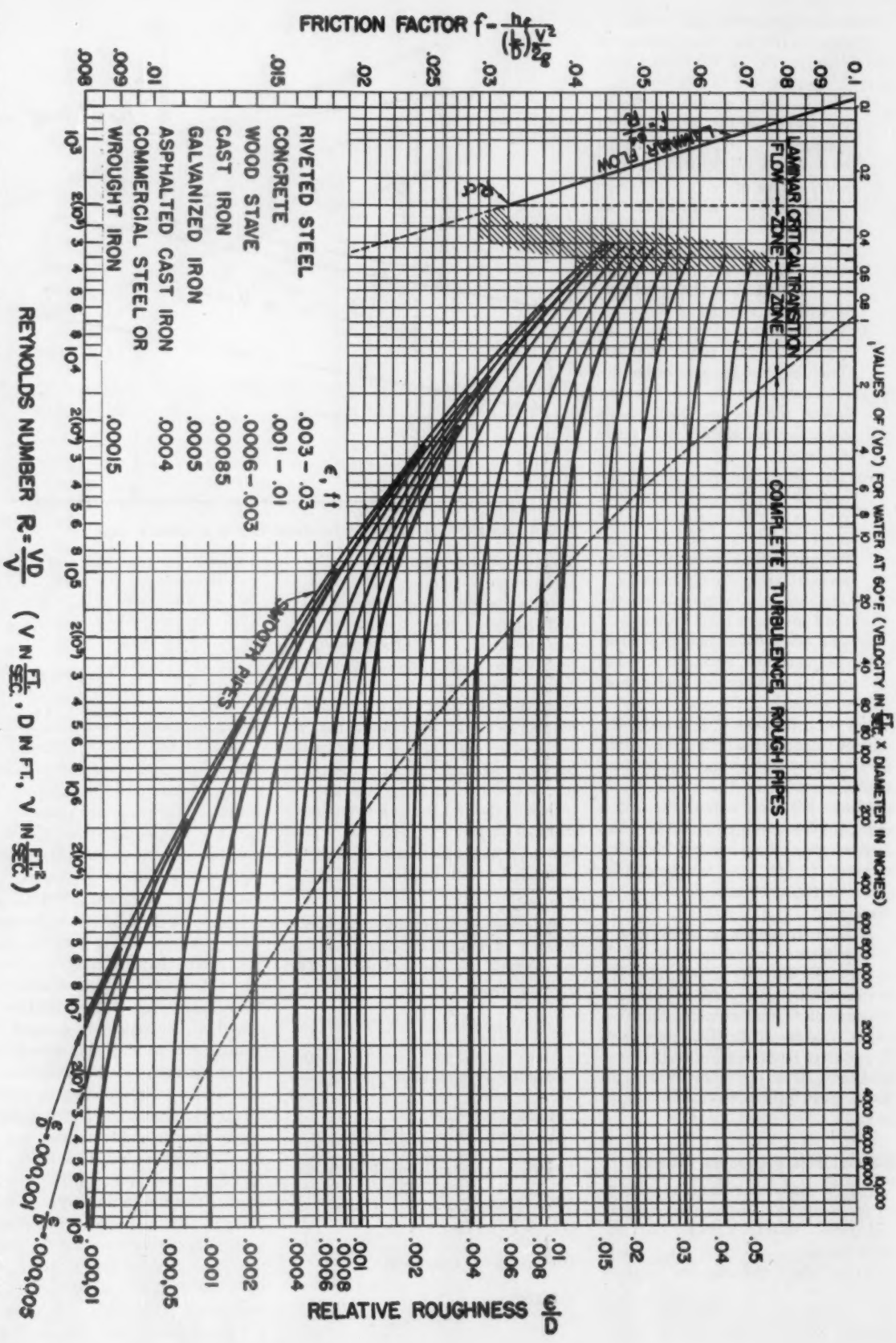

FRICTION FACTOR $f = \frac{h_f}{(\frac{L}{D})\frac{V^2}{2g}}$
VALUES OF (VD) FOR WATER AT 60°F (VELOCITY IN $\frac{FT.}{SEC.}$ x DIAMETER IN INCHES)
LAMINAR FLOW ZONE
CRITICAL TRANSITION ZONE
COMPLETE TURBULENCE, ROUGH PIPES
SMOOTH PIPES
RELATIVE ROUGHNESS $\frac{\epsilon}{D}$
REYNOLDS NUMBER $R = \frac{VD}{\nu}$ (V IN $\frac{FT.}{SEC.}$, D IN FT., ν IN $\frac{FT^2}{SEC.}$)
RIVETED STEEL .003 – .03
CONCRETE .001 – .01
WOOD STAVE .0006 – .003
CAST IRON .00085
GALVANIZED IRON .0005
ASPHALTED CAST IRON .0004
COMMERCIAL STEEL OR WROUGHT IRON .00015
ϵ, ft

FIG. 4 GENERAL RESISTANCE Diagram for uniform pipes

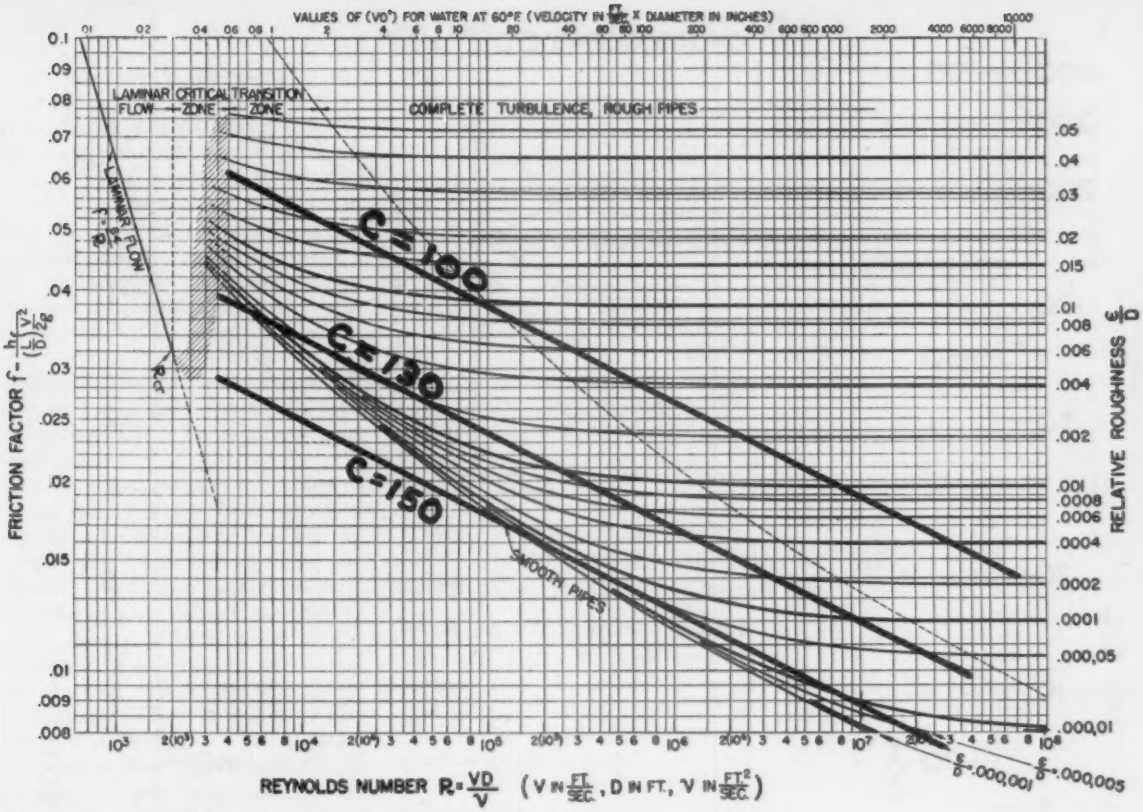

VALUES OF (VD') FOR WATER AT 60°F (VELOCITY IN FT/SEC X DIAMETER IN INCHES)
LAMINAR FLOW
CRITICAL TRANSITION ZONE
COMPLETE TURBULENCE, ROUGH PIPES
C=100
C=130
C=150
SMOOTH PIPES
FRICTION FACTOR f = hf/(L/D)(V²/2g)
RELATIVE ROUGHNESS ε/D
REYNOLDS NUMBER R = VD/ν (V IN FT/SEC, D IN FT, ν IN FT²/SEC)

FIG 5 COMPARISON OF WILLIAM-HAZEN "C" and Friction Factor "f"

a smooth pipe. As the flow rate and therefore the Reynolds number increases, the flow becomes more completely turbulent and the thickness of the film decreases. The roughness projections protrude through the laminar film, and each projection causes additional turbulence which increases the head loss. For the zone in Fig 4 marked "complete turbulence, rough pipes," the film thickness is negligible compared with the height of the roughness protrusions. Viscostity has no effect on the head loss in this zone, as evidenced by the fact that the friction factor does not change with Reynolds number. In this zone the head loss varies *exactly* with the square of the velocity. In the smooth pipe range ($\epsilon/D = 0$) the friction factor varies with the 1.75 power of the velocity. For a given pipe in the transition between hydraulically smooth and rough flow the exponent of the velocity therefore varies between 1.75 and 2.0.

Comparison with Williams-Hazen Formula

The Williams- Hazen formula was obtained by plotting the results of resistance tests for water in pipes of various diameters and materials in logarithmic coordinates. The formula was first presented about 1914 and it is not at all surprising that the complexity of the resistance, as discussed above, was not understood. The formula which was obtained by taking the best straight line "fit" of the data is,

$$V = 1.318\ C\ r^{0.63}\ (h_L/L)^{0.54}$$

where r is the hydraulic radius and is equal to D/4 for a circular pipe. Solving for the head loss, h_L,

$$h_L = \frac{3LV^{1.85}}{C^{1.85}D^{1.17}}$$

From equation [9] it is seen that the head loss always varies with the velocity to the 1.85 power. It is apparent, therefore, that the Williams-Hazen formula should give good results in the transition range between smooth pipe ($V^{1.75}$) and completely rough pipe flow (V^2). This is to be expected since the vast majority of the data used is obtained the formula corresponded to flow conditions in this transition range. The danger inherent in extending the Williams-Hazen formula into the high Reynolds number range of large diameters and flows is also apparent.

The relation between the friction factor f and the Williams-Hazen C can be obtained by equating [7] and [9], solving for f and using the numerical value of the viscosity of water at 60°F, thus:

$$f = \frac{1080}{C^{1.85}\left(\frac{VD}{\nu}\right)^{.15}}$$

The differences to be expected by using C rather than ϵ/D as a measure of the pipe roughness are shown in Fig 5. This is the same plot of the general resistance diagram (Fig 4) with superimposed curves showing the values of f which would be obtained by use of the Williams-Hazen coefficient in equation [10]. Curves for C = 150, 130 and 100 are shown in Fig 5. From this it is seen that a coefficient C = 150 corresponds to a smooth pipe only if the product of velocity (fps) and diameter (inches) is greater than $VD^{11} = 20$. For an extreme case of a one-inch pipe with a velocity of one foot per second ($VD^{11} = 1$) the highest possible C which could be obtained for a smooth pipe would be C = 133.

For a pipe with C = 100 and the

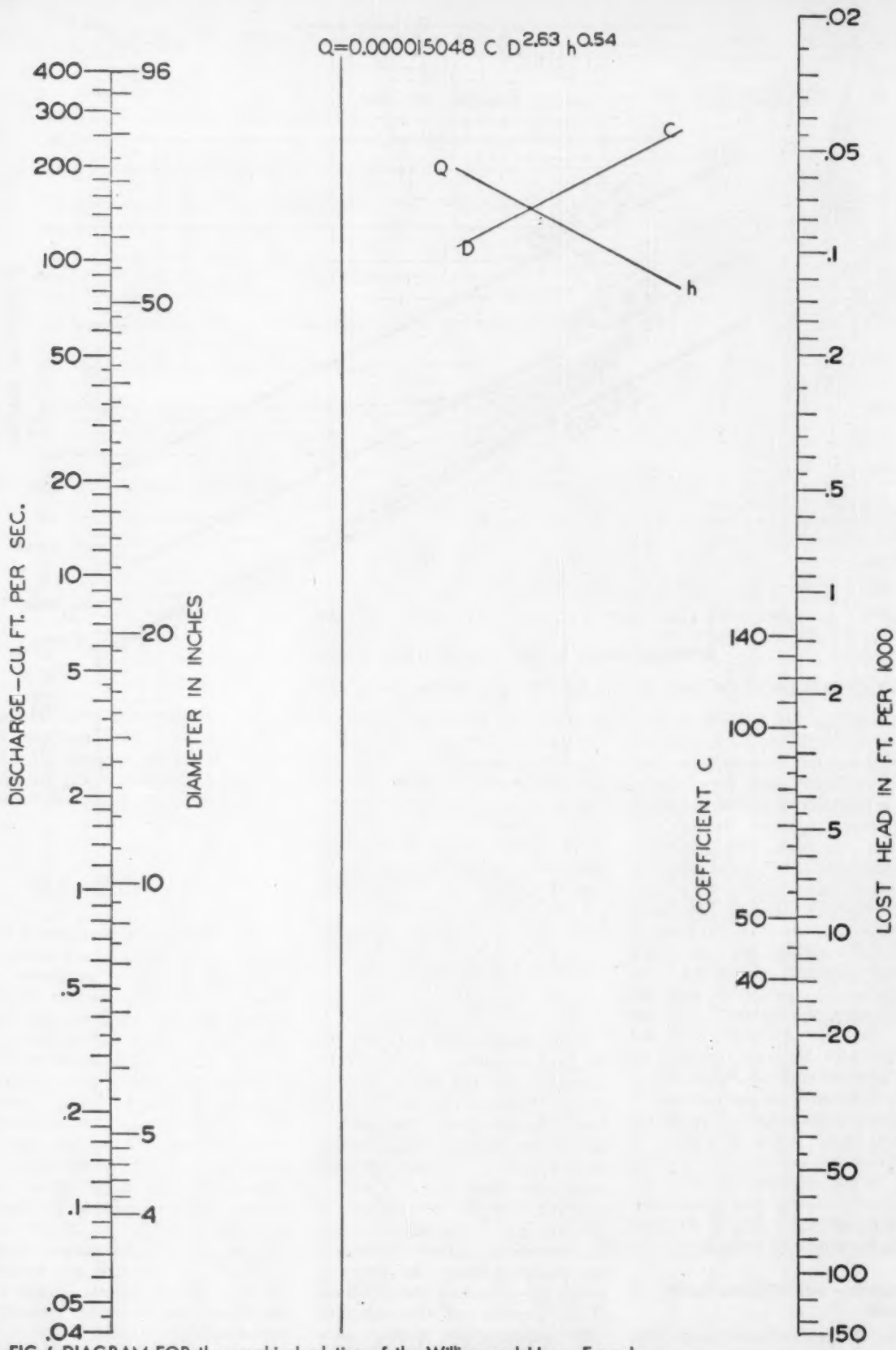


FIG 6 DIAGRAM FOR the graphical solution of the William and Hazen Formula

product $VD^{11} = 15$ the corresponding value of ϵ/D is .01 ft. Under these conditions both Williams-Hazen and the friction factor equation give identical results. On the other hand of the velocity in the same pipe is increased by a factor of 10 so that $VD^{11} = 150$ the value of C would have to equal 82 in order to agree with the head loss computed from the friction factor method. It is therefore hopeless to expect that tests on a single water main under a wide variation of flow can yield a constant value of C. It is however reasonable to expect that such tests would yield a constant value of the relative roughness ϵ/D.

In summary, it is entirely proper to use the Williams-Hazen equation for computation of head loss for the normal pipe sizes and velocities encountered in water supply practice. Unfortunately it is not possible to easily specify definite limits of applicability. It is probably safe to say that for pipe sizes up to 18" no large discrepancies would be expected. For larger pipes in the range of completely turbulent flow the Williams-Hazen formula will give head losses which are too small.

Table 1 gives the recommended values of the Williams-Hazen coefficients for various conduits. In view of the above discussion the C values generally published for pipes in excess of 18" have been omitted from this tabulation. A general nomograph for solution of the Williams-Hazen equation is given in Fig 6.

Absolute Roughness Values for Large Pipes

The discussion of head loss in pipes would be incomplete without a more definite specification of the values of the absolute roughness ϵ to be used with the friction factor equation. The tabulation of ϵ values for clean new pipe given in Fig 4 is by no means adequate for use in cases of large pipes. This is evidenced by the rather wide range in ϵ listed for riveted steel, concrete and wood stave pipe.

Probably the most complete compilation of data on values of the absolute roughness for large pipes has been presented by the Bureau of Reclamation [1]. Fig 7 through 11 provide a detailed description of surface condition and the corresponding values of ϵ for concrete steel, riveted-steel and wood stave pipe.

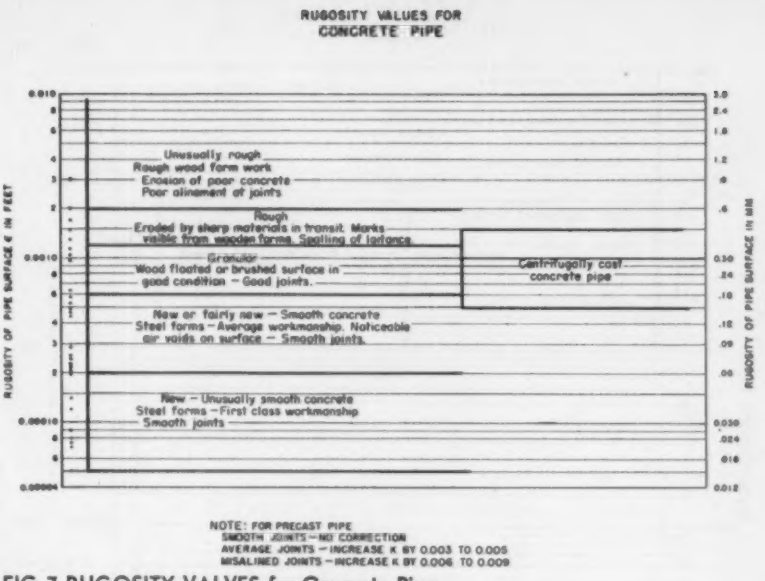

RUGOSITY VALUES FOR
CONCRETE PIPE
RUGOSITY OF PIPE SURFACE ε IN FEET
RUGOSITY OF PIPE SURFACE IN MM
Unusually rough
Rough wood form work
Erosion of poor concrete
Poor alinement of joints
Rough
Eroded by sharp materials in transit. Marks
visible from wooden forms. Spalling of laitance
Granular
Wood floated or brushed surface in
good condition — Good joints.
Centrifugally cast
concrete pipe
New or fairly new — Smooth concrete
Steel forms — Average workmanship. Noticeable
air voids on surface — Smooth joints.
New — Unusually smooth concrete
Steel forms — First class workmanship
Smooth joints
NOTE: FOR PRECAST PIPE
SMOOTH JOINTS — NO CORRECTION
AVERAGE JOINTS — INCREASE K BY 0.003 TO 0.005
MISALINED JOINTS — INCREASE K BY 0.006 TO 0.009

FIG 7 RUGOSITY VALVES for Concrete Pipe

Comparison with Manning's Equation

The use of the Manning equation for head loss calculations in large pipes is quite common. Here again, as in the case of the Williams-Hazen equation, its use is justified provided that it is done so within its range of applicability. For circular pipes, the Manning equation is as follows.

$$V = \frac{1.49}{n} r^{2/3} \left(\frac{h_L}{L}\right)^{1/2}$$

where n is the Manning roughness factor and $r = D/4$.

Solving for the head loss,

$$h_L = (\text{Const.}) \frac{n^2 L V^2}{D^{1.33}}$$

Hence for a given pipe the head

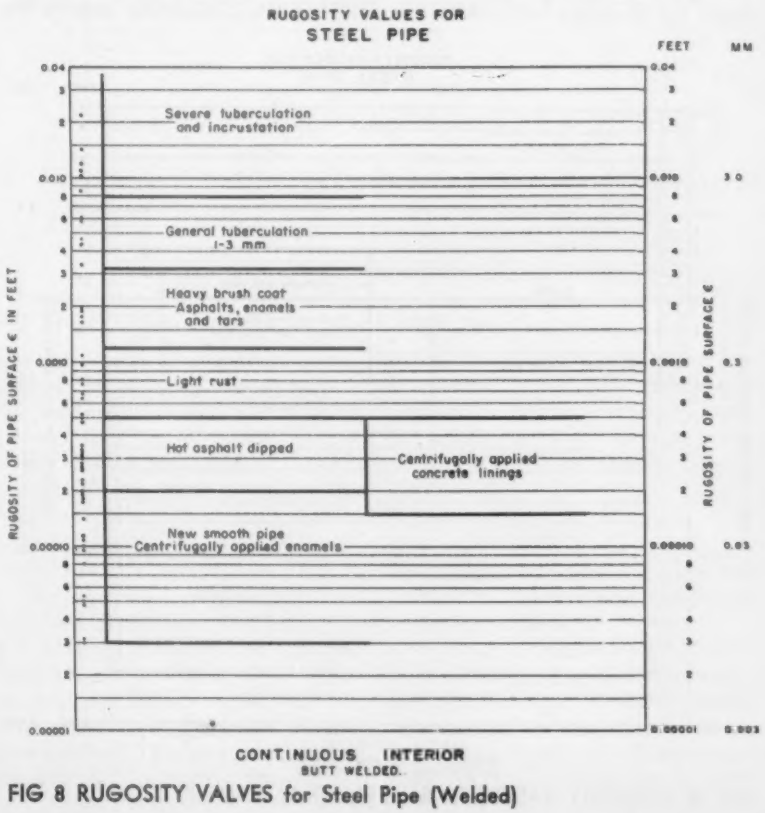


FIG 8 RUGOSITY VALVES for Steel Pipe (Welded)

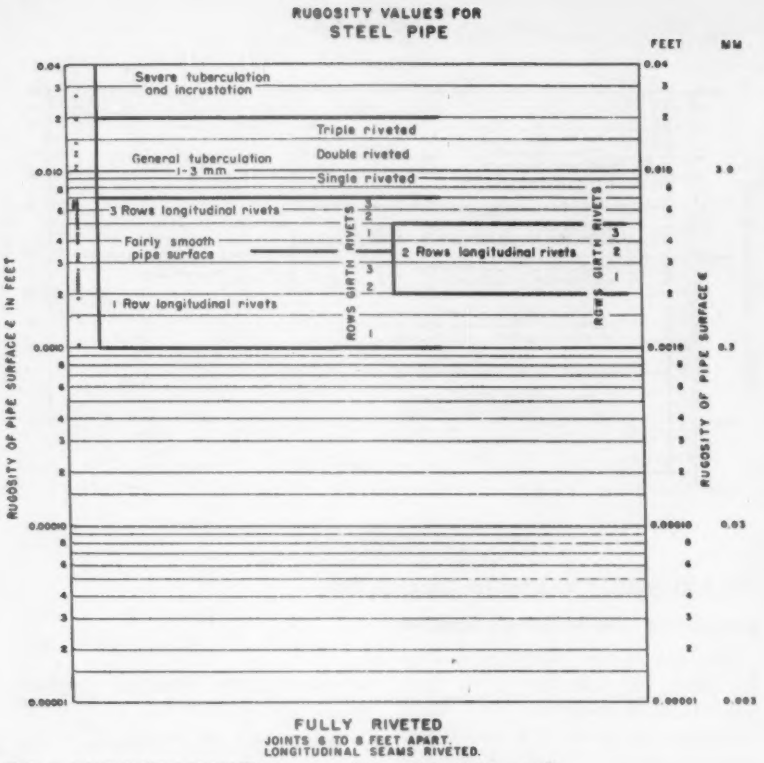


FIG 9 RUGOSITY VALVES for Steel Pipe (Girth Riveted)

loss varies with the square of the velocity for the entire range of flows. From the foregoing discussions this is known to be incorrect and it is concluded that n is a constant describing the boundary roughness only in the range of complete turbulence in Fig 4.

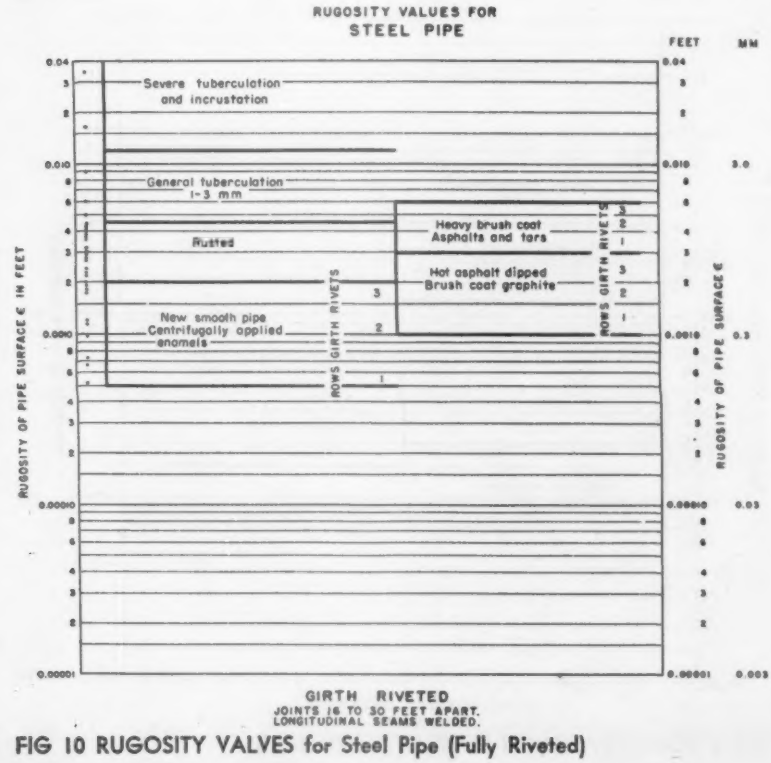


FIG 10 RUGOSITY VALVES for Steel Pipe (Fully Riveted)

Moody[2] has obtained some information on the comparable values of absolute roughness ϵ and the Manning, n:

Manning n
.0105 .011 .012 .013 .014 .015 .016
Abs. Roughness ϵ
.00015 .0005 .002 .005 .011 .02 .03

It is significant that a 7 percent change in the Manning n from .013 to .014 corresponds to more than a hundred percent change in the absolute roughness ϵ (.005 to .011).

In summary, it is concluded that both the Williams-Hazen and Manning formulations have their place in head loss determinations. The difficulty arises in ensuring that they are used only within their range of validity. Neither C nor n can be accepted as an absolute measure of boundary roughness. In this respect the friction factor formulation using the absolute roughness has a definite advantage. The advantages of the older empirical formulations are mainly tradition and familiarity with values of C and n which occur frequently in practice. It is to be hoped that a gradual acceptance of the more rational concepts of frictional resistance will lead to more widespread use of the friction factor approach in the water supply field. As yet no generally accepted direct mechanical method exists for the measurement of any roughness value, however, it has been shown that the absolute roughness ϵ is a much more sensitive measure than any other currently in use.

Head Loss in Fittings

The total head loss for steady flow in a piping system must be treated in two parts:

1. Losses due to frictional resistance in regions of uniform flow, and
2. Losses due to resistances developed in regions of non-uniform flow which occur because of various fittings.

TABLE I
Table of C Values Cast Iron Pipe

Diameter Inches	Age in Years 0	5	10	20	30	40	50
4	130	118	107	89	75	64	55
8	130	119	109	93	83	73	65
12	130	120	111	96	86	77	70
16	130	120	112	98	87	80	72
24	130	120	113	100	89	81	74

Riveted Steel Pipe
  Light riveted steel pipe—
    Avg. C for any age = 10 year C.I.P.
  Heavy riveted steel pipe—
    Avg. C for any age = 20 vear C.I.P.
Welded Steel Pipe
  Equivalent to 5 yr. or older C.I.P.
Wood Stave Pipe
  Best C = 145
  Probable Average C = 120
  Worst C = 110
Concrete Pipes and Pressure Tunnels
  Metal Forms
    Best workmanship— C = 150
    Probable workmanship—C = 140
    Worst workmanship— C = 120
  Wood Form—Monolithic
    Best workmanship— C = 130
    Probable workmanship—C = 120
    Worst workmanship— C = 90
  If Slimed
    20 points below Best
    15 points below Average
    10 points below Worst

In addition to the values in Table 1 the following values of the friction coefficient have been published by the National Tube Co.

These values of the coefficient "C" are to be used in the Hazen-Williams formula for computing the loss of head due to friction in new well-laid pipe:

Kind of Pipe	Coefficient
Wrought Steel	140
Small Brass and Copper	130
Cast Iron	130
Concrete	120
Wood Stave	120
Riveted Steel	110
Vitrified Pipe	110
Brick Sewers	100

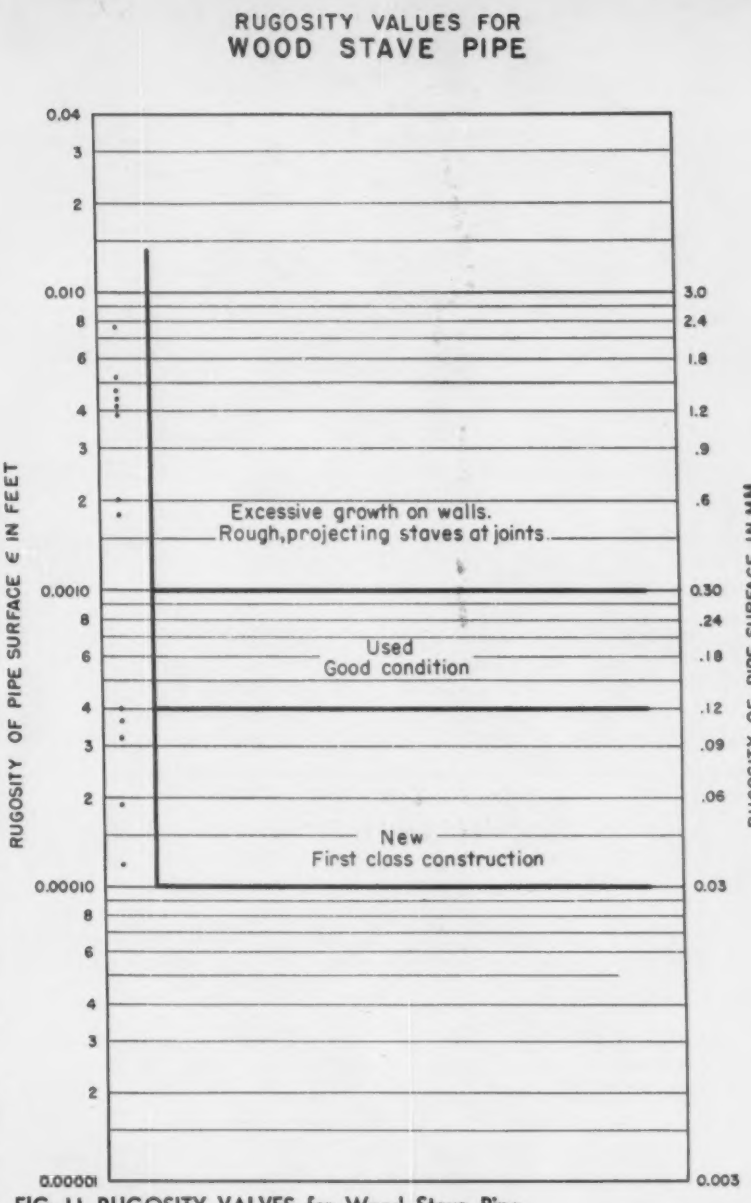


FIG 11 RUGOSITY VALUES for Wood Stave Pipe

If, for example, a long pipe line of constant diameter contains one or more fittings (valves, elbows, etc.), the total head loss is usually obtained by adding the loss due to separate fittings to the frictional head loss for the entire length of pipe. If, on the other hand, the pipe line contains various diameters of pipe separated by fittings (contractions, expansions, etc.), the frictional head loss for each length of constant diameter pipe must be calculated separately and the head loss for each fitting added to the total.

All losses due to fittings occur because regions of non-uniform flow are created. The general pattern is that of an increase in the velocity followed by a decrease in the velocity. A decrease in the fluid velocity almost invariably results in the separation of the fluid stream from the solid boundaries unless a very long, gradual expansion is provided. Between the solid boundaries and the high velocity stream a zone of turbulent eddies are formed which results in the rapid conversion of kinetic energy into heat—hence head loss. In general the larger the zone of eddy formation the larger the head loss. Venturi meters differ from orifice meters mainly in the provision of a long conical diffuser which eliminates the eddy zone downstream of the orifice plate and results in a large saving in total head.

The separation pattern and the definition of the head loss for a typical fitting is shown in Fig 12. The head loss for separating flows which occur in pipe fittings is essentially independent of the Reynolds number and is defined by a constant K, which depends on the geometric shape of the fitting, times the velocity head for the uniform pipe $V^2/2g$. When fittings connect pipes of different diameter (hence different velocities) the velocity head in the *smaller* pipe is always used:

$$h_L = K\frac{V^2}{2g}$$

Approximate values of the loss coefficient for various pipe transitions are given in Table 2.

The bend and elbow losses in Table 2 are for standard small size commercial pipe fittings. A more precise treatment of the head loss in bends and elbows of various radii must consider that the over-all loss is com-

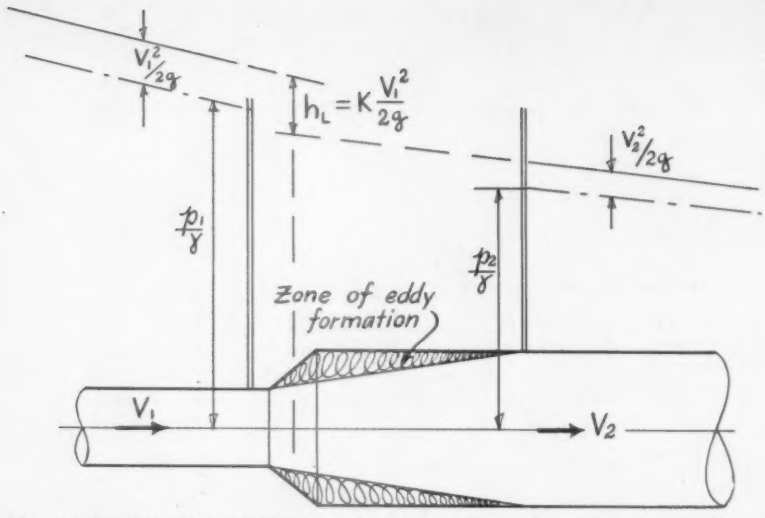


FIG 12 DEFINITION SKETCH for Head Loss through a typical pipe fitting

posed of the following:

1. An equivalent straight pipe friction loss. This is accounted for by including the length of the bend in the total pipe length for the calculation of frictional head loss.
2. A true bend loss, unaffected by Reynolds number or relative roughness, due to the spiral flow which is set up by the bend.
3. An additional loss varying with both Reynolds number and relative roughness and consequently with the pipe friction factor f ($f = 4c_f$ equation [7])

Pigott[3] gives the folowing values of K for 90° bend losses, excluding the pipe friction; i.e. the loss due to 2 and 3 above:

Cast fittings:

D = pipe diameter

r = radius of bend

$$K = 0.16\left(\frac{D}{r}\right)^{1.75} + 44\,f^{1.5}$$

(for r/D less than 1)

$$K = 0.16\left(\frac{D}{r}\right)^{3} + 44\,f^{1.5}$$

(for r/D greater than 1)

Steel pipe and Nonferrous pipe:

$$K = 0.16\left(\frac{D}{r}\right)^{3} + 98\,f^{1.5}\cdot\sqrt{\frac{D}{r}}$$

(for $\frac{r}{D}$ greater than 1)

(not made for r/D less than 1)

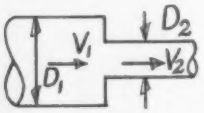
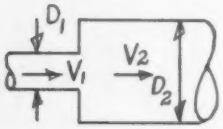
Information on the head loss due to flow through various metering devices has been collected by Spink[4]. The head loss for orifice meters, flow nozzles, short and long cone Venturi meters and Dall tubes are given in Ref 4, page 22-25.

The losses through various specialized fittings such as check valves vary widely depending on the internal geometry. In important installations the manufacturers should be consulted for detailed information.

TABLE II

Head Loss in Fittings

Values of K for $h_L = K\frac{V^2}{2g}$

Type of Fitting	K		
Abrupt Contractions	D_{2D},		K
	0.8		0.13
	0.6		0.28
	0.4		0.38
	0.2		0.45
$h_L = K\frac{V_2^2}{2g}$	0.0	(inlet from reservoir)	0.50
Abrupt Expansions			
	$K = \left[1 - \frac{D_1}{D_2}\right]^2$		
$h_L = K\frac{V_1^2}{2g}$	(outlet into reservoir)	K = 1.0	

90° Bends (radius of bend = r)

r/D	K
1.0	0.40
1.5	0.32
2.0	0.27
3.0	0.22
4.0	0.20

$h_L = K\frac{V^2}{2g}$

Miscellaneous Fittings

	K
Valves: Globe valve (fully open)	10.0
Angle valve (fully open)	5.0
Swing check valve (fully open)	2.5
Gate valve (fully open)	0.2
¾ open	1.1
½ open	5.6
¼ open	24.0
Close return bend	2.2
Standard Tee	1.8
Standard 90° elbow	0.9
Standard 45° elbow	0.4

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3. R. J. S. Pigott; *Losses in Pipe and Fittings*
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GEORGIA WATER and SEWAGE SCHOOL

The twenty-eighth annual meeting featured

Water Resources, Water Quality and Planning

A Staff Report

■ THE TWENTY-EIGHTH annual Georgia Water and Sewage School was held September 9, 10 and 11 on the Georgia Tech campus. The purpose of this school is to provide practical instructions in the field of water supply, sewage and industrial waste treatment. Among the features of the school were a field trip to the new sewage treatment plant of the city of Macon and the waste treatment plant of the Georgia Kraft Corp. Several of the papers presented are abstracted here.

NATIONAL WATER RESOURCES Mark D. Hollis, Asst. Surgeon General, U. S. Public Health Service and Vice President, FSIWA, Washington, D. C.

The population increase in the United States over the last nine years has been greater than half the population of Britain or France. This buildup has been essentially in the urban areas and has resulted in the development of gigantic metropolitan regions around the major cities. These areas around many of the cities are large enough to connect adjacent cities into one huge urban region.

Reservoir sites to supply these demands are becoming increasingly difficult to find. This situation is emphasizing the need for maintaining the highest standards of water quality. The problem is made even more complex since the old concepts of bacterial contamination and disease which were based on epidemiology are not as applicable. We are now faced with problems of microquantities of complex organic pollutants which break down slowly if at all. These pollutants are not necessarily from industrial sources but build up as a result of the present day use of these complex organic chemicals in the home and business for cleaning, disinfection and other uses. Domestic sewage as it was known not too many years ago for all practical purposes no longer exists. It should now be called municipal waste. Present day sewage treatment methods do not remove these complex materials.

Meeting the problem brought on by these complex organic will not be easy as they are problems of slow long term buildups. The long term effects of such a buildup are not easily detected because we have a little knowledge of the problem. These will be the issues of tomorrow and research is the source of the knowledge of how to meet the situation.

WATER QUALITY IN GEORGIA, W. H. Weir, Director, Water Quality Division, Georgia Department of Public Health, Atlanta, Ga.

The problems of water quality are approached with these three points as a basic premis:

1. A determination to maintain a high quality of water in Georgia.
2. Public recognition of this determination and
3. Increasing assumption of responsibility by affected individual groups, i.e. city, country, industry, etc. for the maintenance of water quality

Public contact with water has increased over the last few years. Up until the last few years the public's contact was limited to viewing water from a distance. The increase in leisure time over the recent years has brought about tremendous increases in boating, fishing, swimming and other recreational uses of water. This more intimate contact has generated an increased awareness on the part of the public of water quality.

In the area of assumption of responsibility an example is the work of the county government. The spread of population into the suburbs has required development of county sewage collection and treatment systems. Actually in many cases particularly in states with small counties the spread of population does or will demand an even larger unit of government to provide efficiently water and sewage services. These problems are the result of the demands by the large segment of the population which is shifting to the suburbs for the same services which they had in the city.

One water quality problem which presents itself in Georgia is a result of the industrial expansion. The industries which are coming to Georgia are those which have agricultural products as their raw material, i.e. pulp and paper, meat packing, chicken dressing, textile etc. All of these are organic processers and consequently sources of organic industrial wastes.

Large impoundments of water for hydroelectric power generation, particularly those used to meet peak demands have affected existing downstream water and sewage treatment facilities. To prevent such occurrences we need better coordination between the various agencies, Federal, State and local, involved in dam construction.

MANAGEMENT FOR PUBLIC UTILITIES Fred Lamb, City Manager, Cartersville, Ga.

The essence of public utility management is five sounds. Sound budgeting, sound planning, sound fiscal policy, sound inventory practices

and sound public relations and complaints policy.

Budgeting is sound when it provides adequately for operation expenses, maintenance cost, renewals and extention founds and reserves. Unless however these allowances are based on a sound conservative estimate of income they are to no avail.

Sound planning is made up of proper capital budgeting, adequate engineering and location records. An important item in this section is an established policy on allocation of the cost of extensions.

Rates adequate for self-support are a prime factor in sound fiscal policy. Adequate bookkeeping and cost records are the means by which an adequate rate structure may be established. Proper bill collection, requiring deposits and cut-offs for delinquents are necessary to operate within a proper rate structure. Adequate pay for personnel and sufficient equipment for efficient operation may not appear to belong to sound fiscal policy but when one considers the cost of frequent turnover of manpower as well as the cost of inefficient operation their place here becomes clear. The last and certainly not the least item is regular deposits to the sinking funds for bond retirement.

Lack of proper control of inventory can be an extremely expensive difficulty. It is essential that stock be charged to the proper account when purchased, charged to inventory account and then charge out to the operating account when used. In most cases consolidated warehousing will provide better inventory control as well as economy of operation.

With all the discussion of sound public relations and complaint policies being presented it would seem necessary only to restate the following points:

1. Handle all complaints adequately and promptly
2. Remove cause for complaints
3. Proper meter readings
4. Hold errors to a minimum
5. Cause as little inconvenience to the public as possible.

DESIGN CRITERIA FOR RAPID SAND FILTERS, THE AUSTRALIAN DESIGN Richard R. Kennedy, Partner, Kennedy Engineering, San Francisco, Calif.

The distinguishing features of the enclosed gravity type filters or Australian design is that they consist of multiple interconnected cells controlled by one main distribution valve and one filter rate control with a common collection under-drainage system. Backwash is accomplished as a single cell operation with the production of the other cells furnishing the backwash water.

The main distribution selector valve is the key equipment feature of this filter design. This valve receives the raw water and by proper port arrangement distributes it to pipes leading to each of the cells. One valve connection is for backwash to waste. The operation of this main control valve, which is rotated by electric motor drive, allows backwash water from the top of any cell to go to waste and by rotation through a cycle will successively backwash each of the cells while allowing continuous filtration in the remaining cells. During backwash cycles flow is supplied by the operating cells, thus obviating the necessity for expensive backwash pumps or storage.

Individual cells are constructed as equal sided squares and may be of steel in small sizes or of common-wall concrete construction in larger units. The underdrain system has large plenum channels which are interconnected to each cell within the group. Above the channels is an extremely simple distribution header covering the floor with a bed of normal graded rock and sand filter media. Backwash head loss of 0.8 feet is far below the conventional 15-foot loss. Each cell roof above the top of the sand is constructed in the shape of a truncated pyramid of a size to be completely filled by sand when the sand is 50 percent expanded. At the top of the sloped roof is a baffle plate and pipe outlet connecting to the master valve. Each filter has an open vent pipe carried above the level of the sedimentation tank to avoid entrained air or siphon action. A single effluent rate of flow controller controls the discharge of treated water from the large plenum channel underneath the sand beds.

THE LAKE MICHIGAN SHORT FILTER RUN STUDY M. B. Gamet, Prof. of Civ. Eng. Northwestern Technological Inst., Evanston, Ill. and J. M. Rademacher, San. Eng, USPHS, Chicago, Ill.

This paper is a description and presentation of selected data and analyses of the study which is currently being made of the short filter run problem on Lake Michigan. Since the field study is still in progress, investigation and analysis of data from all twelve filtration plants cannot be completed until all data is received and processed. However, the following tentative conclusions may be drawn from the data, and results of analyses presented.

1. The magnitude of the short filter run problem is indicated by the fact that 37 percent of the runs for all of the test filters were under 20 hours for the nine month period studied.
2. The "clump count" procedure for algae determination has proved very satisfactory with respect to technician proficiency and time requirements. No difficulty is expected in the conversion of this data to volumetric equivalents with the use of the digital computing facilities.
3. *Tabellaria* is the most important of the plankton organisms exhibiting filter clogging tendencies in Lake Michigan. High concentrations of other plankton in combination may be a factor but no other single organism appears to be as significant.
4. Turbidity of the settled water has not been a factor involved in short filter runs.
5. It is suggested that nannoplankton, excreta from micro-organisms or siliceous gel may be possible factors contributing to short filter runs.
6. Adequate flocculation and sedimentation are needed throughout all operating ranges up to the design capacity at a plant, if proper treatment is to be effected.
7. The length of filter runs shows marked increases when ferrous sulfate is used for coagulation instead of alum.
8. The overall loss in revenue to the participating plants is estimated to be $226,000.00 for the nine month period. This includes the $12,500.00 for excess wash water production costs.
9. The need for a satisfactory quantitative treatment index to replace the qualitative measurements now in use for water

treatment plant control is demonstrated.

10. The use of polyelectrolytes should be more thoroughly investigated as a possible supplemental treatment during short filter run periods.

MECHANICS OF BOND ELECTION CAMPAIGNS F. H. Eastman, Secretary, East Bay Munic. Utility Dist., Oakland, Calif.

A discussion of this subject logically divides itself into four areas, namely

1. Planning for a bond issue election. 2. Organization of the campaign. 3. Conduct of the campaign. 4. Follow-up after the election.

In the planning phase it is suggested that a well-rounded program of public relations be developed and maintained at all times in order that we may always be in the strongest possible position to present a bond proposal to the voters.

A broad outline of the general project is needed at an early date as a basis for planning for the bond election as well as an analysis of the probable public reaction to our specific bond proposal. This will enable us to more intelligently plan our presentation to the public and to make important decisions regarding the bond proposal. Verification by an outside group, of the necessity for the project and of its engineering and financial features is important to secure public "belief" in the program.

During the organization period the following points should be considered:

1. The formation of a Citizens' Committee is essential since the public agency cannot legally campaign actively in support of the bond issue.

2. The primary function of the public agency in the campaign is to prepare the basic bond issue story and to complement the activities of the Citizens' Committee by disseminating factual information regarding the project and the bond proposal.

3. The Citizens' Committee must raise the money and conduct the campaign.

4. The campaign must be operated on a cash basis.

5. A paid campaign director provides the best method of coordinating the Citizens' Committee activities and "plugging the holes" when a volunteer is unable to perform.

Of practical necessity, most bond campaigns start slowly and build up momentum as election day approaches. In the early stages of the campaign, money is short; campaign materials are being developed by the publicity and advertising committee, but are not yet available; paid advertising is being saved for the last few days of the campaign and many of the detailed plans of the Citizens' Committee are still being worked out.

It might be well to mention here that it is most important throughout a campaign of this type to hold back your big "ammunition" for the climax and to resist the temptation to "go all out" too early when there may be a feeling that the campaign is dragging.

For example, regardless of how strong your local newspapers are supporting you, there is practical limit to how much space they can give a single activity. Furthermore, your press releases must have news value and you simply can't keep repeating the same material. Thus, if you flood the papers with release and tell the whole story too early in the campaign, the well will run dry just when you need the publicity the most—the last few days of the campaign.

Similarly with paid advertisements. Seldom is there enough money to pay for more than a few days of concentrated ads. These are most effective immediately before the election and, therefore, should not be used too early in the campaign.

In concluding this discussion today, I would like to mention the desirability of certain follow-up action following a bond campaign. Certainly it is obvious that a systematic method should be devised to express appreciation to the voters generally and specifically to the Citizens' Committees who are entitled to the major share of the credit for a successful campaign.

A precinct-by-precinct review of the vote result in a bond issue provides one of the best and certainly the cheapest public opinion polls that can be obtained. Such a study will reveal areas of strength and weakness that will be most helpful in adjusting your operations and public relations programs as you start now to plan for your next bond issue.

9-Point Water Program For Kentucky

A recommended nine-point program designed to emphasize the importance of water in the state was unveiled by the Kentucky water Resources Study Commission in a report prepared for distribution to Governor Chandler and the 1960 state legislature.

The study commission was set-up by the 1958 legislature under the State Division of Flood Control and Water Usage. Commission Chairman Lee Bolin said its recommendations would be submitted to the new legislature in January, calling for:

1.—Further development of public awareness in water resources programs.

2.—Better and more economical methods for treating water for domestic uses, as well as for treatment of sewage and industrial wastes.

3.—Additional Studies of water uses and needs for small watersheds throughout the state.

4.—A statewide program for investigating and mapping underground water.

5.—A survey of waterfront areas to zone or reserve the best sites for future industrial expansion, especially those industries requiring large water supplies and water transportation facilities.

6.—Establishment of a fair water rights law.

7.—Creation of a central state agency to have jurisdiction over the principal water activities in Kentucky.

8.—A program of financial assistance for areas without money so municipalities may build, operate or expand water treatment facilities.

9.—A law requiring the registration of all outboard and inboard motor boats over 10 horsepower if they are to be used on navigable streams.

Kansas City's Sewage Problem

Mayor Mitchum of Kansas City, in another effort to comply with a federal order that the city have a comprehensive program under way to curtail river pollution by Jan. 1, appointed a citizens' committee to arrive at an equitable method of taxing industrial, commercial and domestic sewer users to finance construction of a sewage treatment plant and separation of storm and sanitary trunks.

Using a steel strong back as shown to keep sections of pipe rigid during installation facilitated . . .

Replacement of Outfall Sewer *at Ft. Belvoir, Va.*

■ ACCIDENTAL DAMAGE and subsequent clogging of the existing line required replacement of the outfall sewer from the Ft. Belvoir, Va. sewage treatment plant. This line which is 725′ long discharges into the navagation channel in the Potomac river. Average discharge is 1.1 mgd with maximum capacity 2.38 mgd. The treatment plant consists of two Imhoff tanks with effluent chlorination serving a population of 13,000.

The actual construction was begun by scooping out with a clamshell a trench six feet deep to accommodate the pipe. The distance from the top of the trench to the river surface varied from four feet near the shore to eighteen feet at the channel edge.

Thirteen-foot lengths of 12 inch asbestos cement pipe were assembled 20 miles up river into 65′ sections and carried by barge to the installation site. At the site, each 65′ section of the pipe was attached to a steel strongback in order to keep it rigid as it was being lowered into the trench.

Installation

Actual installation of the pipe was accomplished through the teamwork of the crane operator who lowered the pipe into the water and a diver who guided the pipe into position in the trench. Extremely muddy water obscured the diver's vision resulting in his completing the underwater connections virtually by feel. Good voice contact between the diver and the crane operator enabled the latter to swing the crane's boom gently enough to allow the diver to guide the long section of assembled pipe into coupling left on the end of the previous assembly. Despite the apparent adverse conditions under which the diver worked, it took only a little more than an hour per section to make the underwater connections, unfasten the chains securing the pipe to the strongback, inspect for voids under the pipe and check the position of the couplings in the assembly.

Contract period for the installation extended from August 18 to October 29. This included the trench digging operation, assembly of the pipe sections above the water, transportation to the site and the underwater assembly.

Pilot plant studies are reported on . . .

Sludge Dewatering *by Vibrating Screens*

by FRIEDRICH KIESS, Dr. Ing;
and CARL SCHRECKEGAST,
Chemist, Wuppertal Sanitary
District, Germany

EDITOR'S NOTE: Since 1941 the Wuppertal Sanitary district has been engaged in studies of various methods of dewatering sludge. These have included vacuum filtration and several other methods not too well known in this country. The vibrating screen approach was developed in conjunction with a company within the sanitary district which produces equipment of this type for industrial application. When using a combination of a course screen, a sonic screen, a sonic filter and a roll press data is reported which shows dewatering of digested sludge to 35 to 40 percent solids.

■ SLUDGE DEWATERING has become a major problem today for all larger sewage plants. While smaller plants can be operated now as before with the drying of the digested sludge on drying beds[1], engineers are looking more and more for artificial drying processes for the larger plants, because the sludge drying on beds has considerable disadvantages for these plants. For one thing it is frequently impossible to obtain suitable space for necessarily extensive drying beds, and also the operational costs of the drying beds are high because considerable labor is involved. The operation is also dependent to a high degree on the weather conditions. The wasting of sludge into lagoons and old stone quarries can offer only temporary relief. For the larger sewage plant it is therefore essential to employ artificial dewatering methods for the sludge sooner or later.

At the present time, there are several processes for artificial sludge dewatering, which operate on a static or on a dynamic principle. In the former group, the vacuum and pressure filters may be included, and in the latter group are the screening and filter machines. Of all these processes developed to date only the vacuum filters have proven their value in practical operation[2]. If this process up to now has been applied in only a few installations in Germany, in contrast to the United States where the conditions for this type of unit are more favorable, it is because of the relatively high operation costs which are required by such installations. According to Stuewer [1], the operation costs amount to at least DM 4.50/m³ (about 3 cents per cu ft) of digested sludge, if a large installation is involved. With smaller installations, the costs are relatively higher.

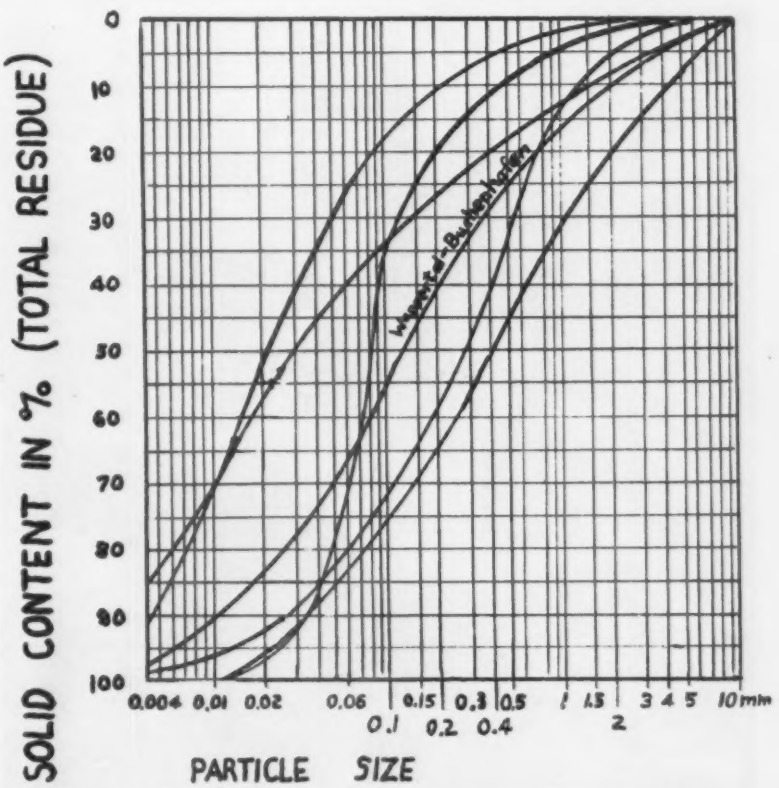


FIG. 1 SIEVE ANALYSES for digested sludges from various German sewage treatment plants.

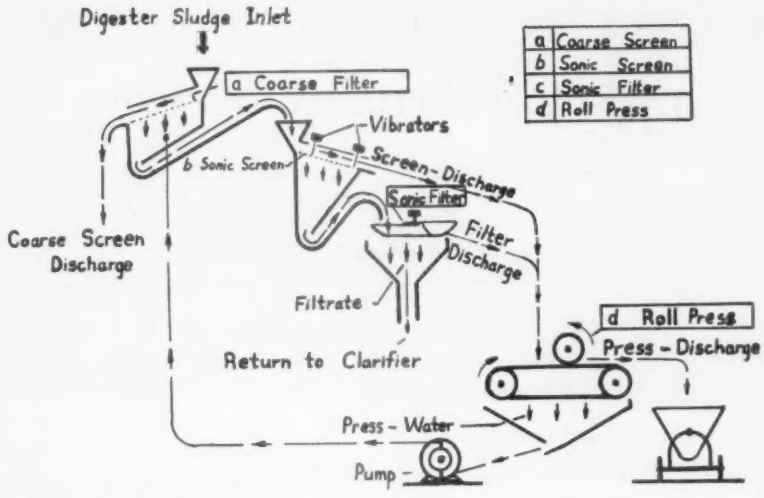


FIG. 2 FLOW SHEET of dewatering process.

Sludge drying with pressure filters and centrifuges is still in the experimental stage. Other processes, which have proved themselves more or less, of which we here would like to mention are the sludge press, Russel and Stengelscreens, the Edcofilter, the sludge superheat and the sludge refrigeration process. These methods are in the experimental stage in Germany[3][4][5].

The Wupper Sanitary District in Wuppertal-Buchenhofen, had been testing without success various methods of sludge treatment for several years. This District in 1941 had already undertaken tests with a vacuum filter that was made available by the Dorr-Oliver Company of Amsterdam. Although the tests of this process proved satisfactory, this process did not go into full scale use because of the need for large amounts of chemicals and the resulting high operating costs. The District made tests in 1946 on the Heymann apparatus over a considerable period of time, but the results were not satisfactory. With the Heymann Dryer, the big problem was the passage of relatively large amounts of solids with the filtrate which made it necessary to pass the filtrate through sandbeds to remove additional solids from the filtrate.

Because of the fact that the solution of the sludge handling question at the Wuppertal-Buchenhofen sewage plant became more and more urgent, the Sanitary District contacted its member firm Rhewum at Remscheid-Luettringhausen with the request to make some tests on dewatering of digested sludge with their high-capacity sonic screen designed by Dr. Brueninghaus.

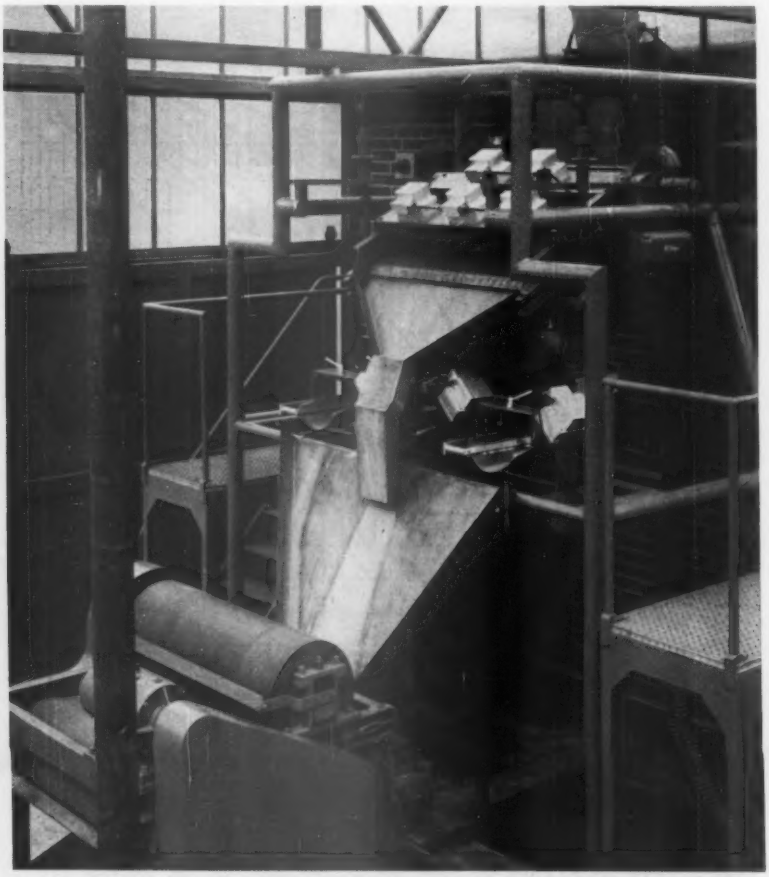


FIG. 3 THE PILOT unit in operation.

The Rhewum Filter for Sludge Dewatering

The basic apparatus involved consists of a filter, vibrating in several planes simultaneously, introduced a new approach to filtration. The essential item of the filter consists of a loosely suspended screen cloth which is vibrated by means of an electromagnets attached to one edge of the filter cloth. The energizing of the filter screen is done at a basic frequency of 100 Hz, which is superimposed by harmonic frequencies extending high into the sonic range. By means of this, there are formed initially on the side of the electromagnetic vibrator longitudinal waves, while in the curved portion of the filterscreen strong transverse waves are primarily effective. While the latter produce an extremely rapid dewatering effect, the longitudinal waves move the solids from the zone of the transverse waves, agglomerate the solids, densify the solids, and by proper adjustment of the filter screen the filtered material is continuously removed from the screen filter in a thick ropelike form.

The filters do not require any special attention, since clogging does not occur. The filter-screens keep them-

selves clear through the continuous removal of the solid particles, which to a great extent glide over the filter surface and which are partially retained in suspension above this surface, while the carrier liquid flows through the screen mesh[6].

The Test Apparatus

At first, more than 100 tests were made with a Rhewum sonic laboratory analyser in order to determine the granular structure of the digested sludge at the Wuppertal Plant.

Similar tests were made with the digested sludge from other plants whereby it was determined that the granular structure of digested sludge can differ over wide ranges (Fig. 1). It is, therefore, required to determine the granular structure of the sludge before any sludge dewatering is attempted.

Following these preliminary tests, the Rhewum Company made a multistage pilot plant installation constructed in accordance with plans by Dr. Brueninghaus available to the Wupper Sanitary District. This pilot plant was installed in the Wuppertal-Buchenhofen plant, and it is shown schematically in Fig. 2.

The installation consists of the following separate pieces of apparatus:

a) Course screen with 8 x 24 mm mesh.
b) Sonic wet screen with screen mesh varying as selected, from 2 mm to 1.2 mm.
c) Three sonic filters with square mesh varying, as selected, between 0.5 mm and 0.1 mm.
d) Roll press with recirculation system of the press water.

The vibration of the sonic screen and sonic filters are produced by electromagnetic vibrators developed by the so-called sonic vibrator heads. Fig 3 and 4 show pictures of the pilot plant installation.

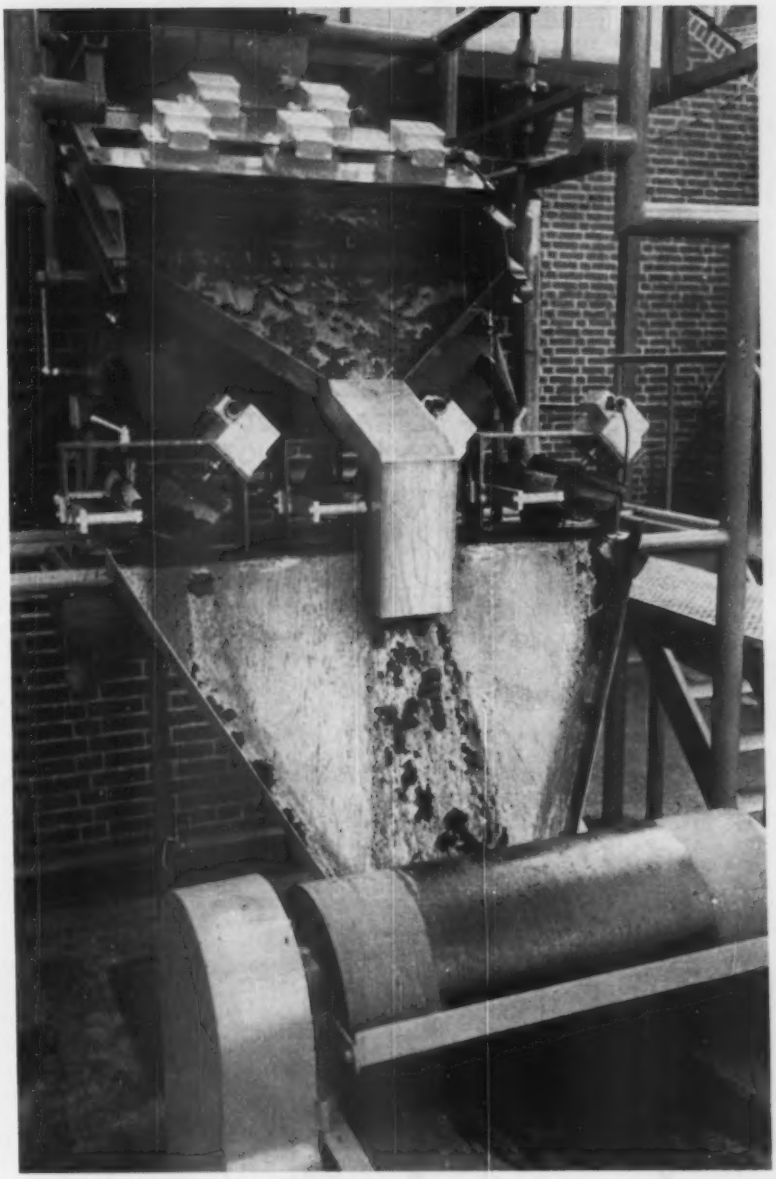
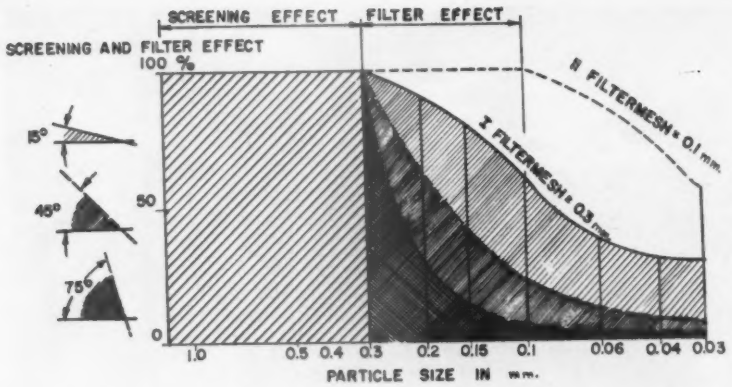


FIG. 4 ANOTHER VIEW of the pilot plant.

Operational Experiences

The filtering effect of the sonic filter is dependent on the loading, particles size, and solids dispersal, which vary with the particular sludge as pointed out previously. During the operation of the pilot plant, a further important observation was made, when it was determined that the filtering effect depends to a great degree on the angle of the sludge discharge nozzle with the filter cloth. This relationship is represented graphically in Fig 5. At the left hand side is shown the angle of inclination for three specific conditions of 75°, 45° and 15°. On the right hand side, aside from the screening effect, is shown the additional filter effect for each condition as a percentage, using a filter mesh of 0.3 mm.

From the individual curves, it becomes evident that the greatest separation occurs the closer the discharge nozzle approaches a tangential direction. With a 15° angle of discharge for example it may be noted that, with a 0.3 mm filter cloth, about 90 percent of all particles of 0.2 mm in size, 80 percent of all particles of 0.15 mm in size, and 60 percent of all particles of 0.1 mm in size are filtered out. On the basis of this experience, it is proposed to use filter meshes of 0.1 mm which will be specially made for use with these vibrators. The additional separation of particle sizes would then be as represented by curve II, Fig 5. In that case, it should be expected that about 60 percent of 30 micron sized particles would be filtered out.



DEPENDENCY OF FILTER EFFECT ON INCLINATION OF DISCHARGE NOZZLE

FIG. 5 EFFECT OF NOZZLE discharge angle on performance.

Capacity of Apparatus

Fig 6 illustrates the screening and filter capacities of a Screen, Filter, combination machine. The data shown are average values which were obtained with the pilot plant installation at Buchenhofen. On the left hand side of the picture is shown the sludge analysis of the digested sludge at Buchenhofen with regard to particle size. As may be noted from the illustration, the coarse screen removed about 2 percent of the total solids. These materials, consisting of leaves, wood chips, fruit stones, textile wastes and other coarse materials, are removed first. The following sonic screen, which was equipped with 1.5 mm V2A stainless steel mesh, removed about 23 percent of the total solids as a result of the combined screening and filtering effect of this unit, while the subsequent sonic filters removed an additional 55 percent of the total solids, likewise through the combined screening and filtering effect. The discharge from the sonic screen, as well as the discharge from the sonic filter contain approximately 75 to 80 percent water, and this material is therefore in condition to be pressed.

The discharge from the sonic screen and from the sonic filter are conveyed together to a rollpress which produces a further reduction in the moisture content to about 60-65 percent. The resulting sludge is so dry that it can be readily used for various purposes, such as for agricultural use, mixing with garbage and rubbish, combustion, etc. The filtrate from the roll press was continuously returned to the influent of the sonic screen by means of a pump. The filtrate from the sonic filters contained, solids varying from a maximum of 20 percent to a minimum of 5 percent of the total solids in the initial sludge, depending on the sludge to be dewatered, when 0.3 mm screen mesh was used on the sonic filters. It is therefore possible to remove from 80 to 95 percent of the total solids from the sludge. These results compare with those obtained with previously utilized equipment, in which on the average only about 30 percent of the total solids were removed. Simultaneously, the filtrate from the sonic equipment has excellent sedimentation properties, so that the possibility exists of returning this filtrate to the sewage plant influent. It should be expected that this filtrate would assist in the sedimentation of the raw sewage.

The capacity of the combination apparatus is dependent on this number of sonic filters used. The smallest combination apparatus has two sonic filters while the largest has five sonic filters. Each combination unit is equipped with a coarse screen, a sonic wet screen sonic filters, as well as roll press. The capacity of the sonic filter, starting with an initial sludge of 8 to 10 percent dry solid content, is on the average about 1 cubic meter (about 35 cu ft) per hour. With two sonic filters, it would be possible to average about 2 cubic meters per hour, and with five sonic filters about 5 cubic meters per hour of sludge could be dried to a 60 percent moisture con-

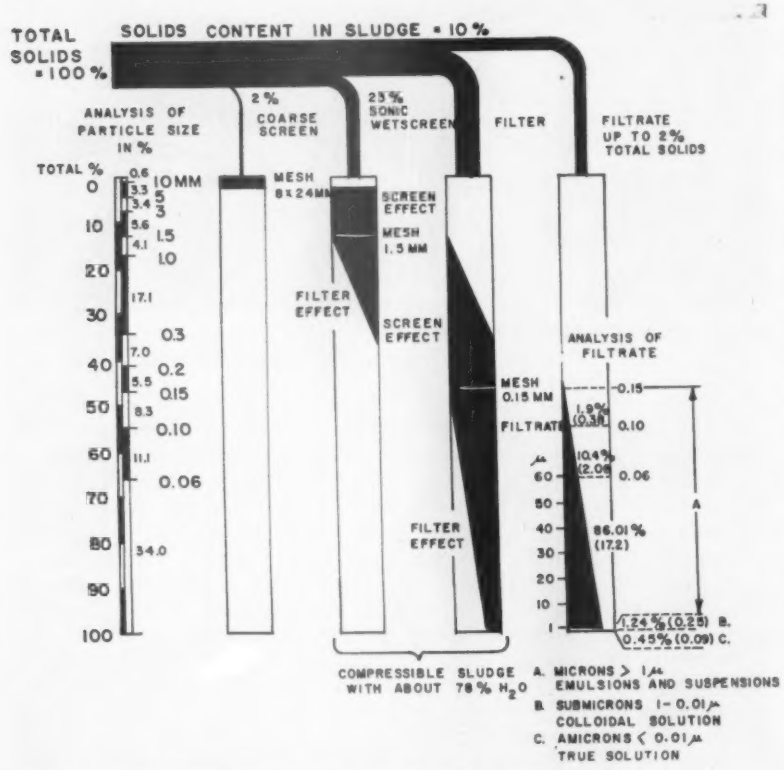
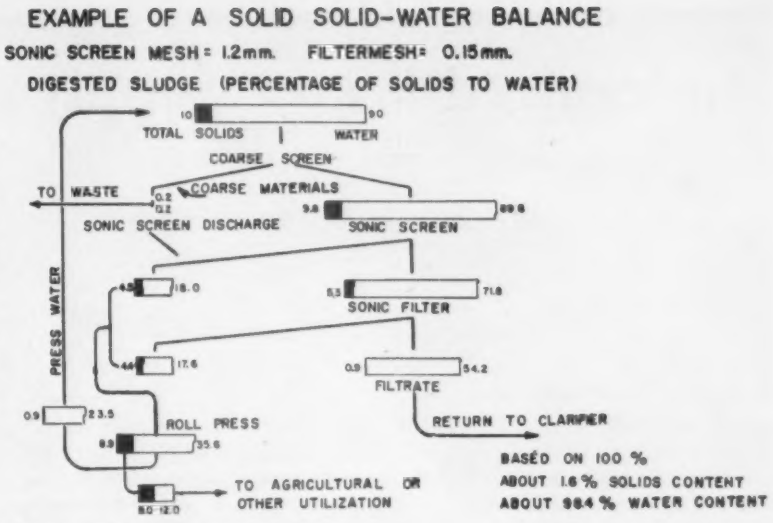


FIG. 6 SCREEN AND FILTER Effects of the Individual Units.

tent. If a greater capacity is required, it would be necessary for a 6 cubic meter per hour capacity to use two units with three sonic filters each. The value of 1 cubic meter per hour for each sonic filter is to be used as a general guide only, and this figure may vary considerably with the type of sludge encountered. It is therefore recommended that the sludges be analyzed in advance. Fig 7 shows an example of a solids—moisture balance, what percentage of solids remain in the respective discharges and filtrates and what percentage of the total solids remains finally in the filtrate.



FG. 7 TYPICAL Solid-Water Balance.

Sludge Dewatering Costs

In order to dry 1 cubic meter of sludge, only 0.7 to 1.1 Kwh are required, depending on the size of the installation. The reason for this low power consumption lies in the fact that the production of vibration for this equipment by means of electric-magnetic sonic heads required little electrical energy. Also the labor costs are relatively low, as the sonic screen and sonic filters require little service, since few adjustments are necessary at the start of the dewatering operation and to clean the apparatus upon completion of the day's operation. This statement assumes that adequate storage facilities for the raw sludge and transportation facilities for the dried sludge are available. Maintenance is relatively low according to past experience, as the sonic screen as well as the sonic filters have a long life. In Fig 8 and 9 are shown preliminary investment and operation costs. For an example, the complete investment cost for a city of 100,000 inhabitants (primary treatment) amount to about 80,000 DM ($20,000.00). The operation costs amount to about 0.60 DM ($0.15) per cubic meter of digested sludge. In these estimates it is assumed that the daily operation is 10 hours. For small and medium sized installation, it will be advantageous to limit the sludge drying period to a few hours daily, while the large plants, where at least two shifts of operation are worked anyway, a longer drying period than 10 hours will produce more economical results.

The capital investment costs amount to about 0.80 DM ($0.20) per cubic meter, if an amortization rate of 10 percent is calculated. The preliminary costs for an installation to serve 100,000 people are therefore about 1.40 DM ($0.35) per cubic meter of digested sludge.

Summary

The pilot operations with the Rhewum combination machine for dewatering of sewage sludge and the results obtained demonstrate that many application possibilities are to be found in the sludge handling field, and that this equipment may be useful in this field. On the basis of the economy of this process, it might be possible to solve sludge handling problems in a satisfactory manner.

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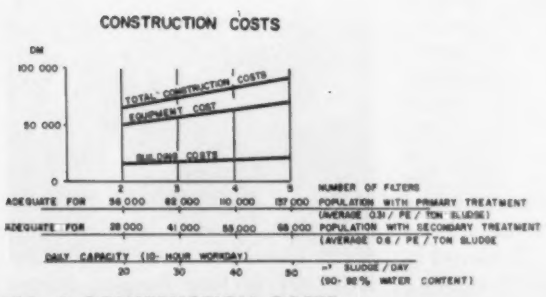


FIG. 8 CONSTRUCTION COSTS.

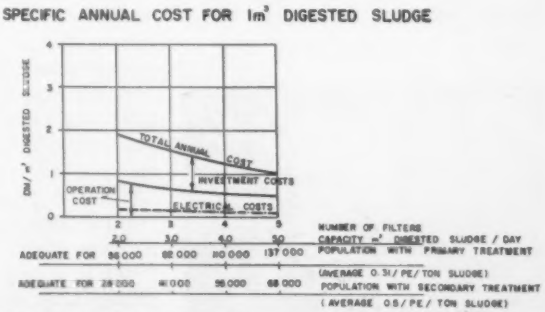


FIG. 9 ANNUAL COSTS for one cubic meter of digested sludge.

Community growth required of Lyons, Colo. a . . .

Modernized Water Supply

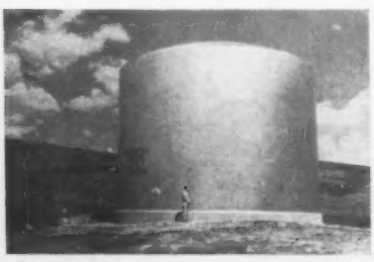
BY V. A. VASEEN
Ripple & Howe, Inc.
Denver, Colo.

■ THE TOWN of Lyons, Colorado is located in the foothills, approximately 50 miles northwest of Denver, a tourist community and the south gate to famous Estes Park summer resort, as well as major hunting and fishing areas of the north central part of Colorado.

When it commissioned an engineering report in March of 1957, Lyons had a population of approximately 750 people. However it had several subdivisions in the planning stages which would add an additional 155 persons as well as several hotels, about 10 motels having the capacity to house an additional 162 persons, a business district and other miscellaneous units on the drawing boards. It was estimated that this would bring the equivalent population to approximately 1200 people. Therefore it was recommended that the system be designed for a population of 1500, but in such a way that it could, in the future, be easily expanded if found necessary.

Source

The Town of Lyons derives its water supply from two major sources; (1) North St. Vrain Creek and its many tributaries, and (2) the secondary source, a 4-inch tap on the raw water effluent line from the City of Longmont reservoir which discharges into the Lyons intake structure.



NEW 300,000 gallon storage tank.

The intake and existing structure, several miles above Lyons on St. Vrain Creek had minor repair work to replace weathered concrete and the addition of two control gates making it possible to close off St. Vrain Creek and clean the intake screens.

Existing System

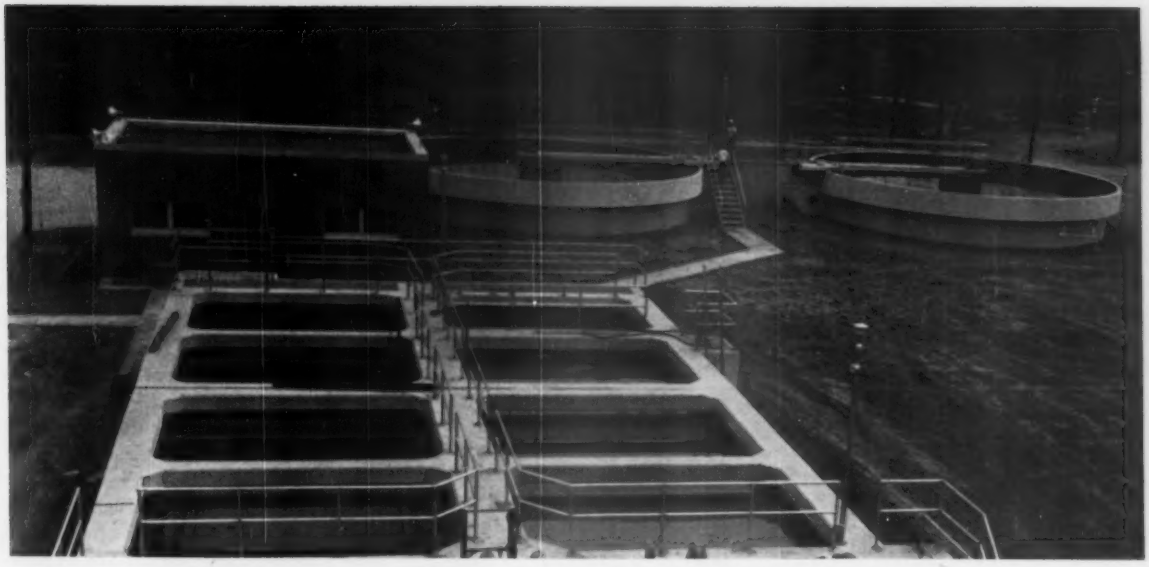
The water supply for the town prior to revision, consisted of an old pressure filter station with hypochlorination installed in the early 1930's. Filtering consisted of two vertical type pressure filters with capacities of 235 gpm each. These pressure filters were on direct connection to the distribution system and did not offer a chlorination contact time sufficient for good engineering practice or to be satisfactory to local departments of health. Lyons had one existing 100,000 gallon steel storage tank, on the side of a hill, which was insufficient to meet the requirements of the community for its domestic load alone, much less for fire demand.

The addition to the supply included a wet-pit following the pressure filters to provide chlorine contact time and a new chlorinator. Since it was necessary to intercept the original gravity flow line, (the raw water intake is at an elevation above the old storage tanks) it was then necessary to add sufficient pumps to the system to elevate this chlorinated water to storage. Currently one 125 gpm, and one 250 gpm vertical turbine pumps have been installed and piping gallery and controls built into the system for an additional 350 gpm pump which will probably be required for the summer season for 1959. The pumping system elevates chlorinated water to a new 300,000 gallon, steel storage tank, set on a hill selected to have a high water elevation approximately the same elevation as the intake structure of the raw water supply, thus making it possible during emergency for the City to have water even though there was a power failure. This water would not be chlorinated through the automatic chlorinator, but could be chlorinated with little effort by hand at the elevated storage by town personnel.

The original water system was entirely a manual operation and consequently was subject to the ordinary human factors of manual control. The new system is completely automatic with the controls in a new pump house adjacent to the old filter plant. The control system will automatically add or subtract from the system the three pumps in various combination, thus giving the community seven possible selections of pumping capacity in heads to meet its requirements during minimum and maximum hours.

The Town of Lyons now has a water system meeting all of the requirements of the Colorado State Board of Health and able to furnish at all times, filtered, chlorinated water, as well as protect the Town with sufficient additional water to meet the Mountain States Inspection Bureau (a division of National Underwriters) requirements for fire demands. Cost of the improvements was $76,471.00.

INTERIOR of New Pumping Station Showing 250 gpm and 125 gpm pumps.



A view of the treatment plant built as part of the new

East Ridge Sewage Works

by L. A. SCHMIDT, JR.
Consulting Engineer
Chattanooga, Tenn.

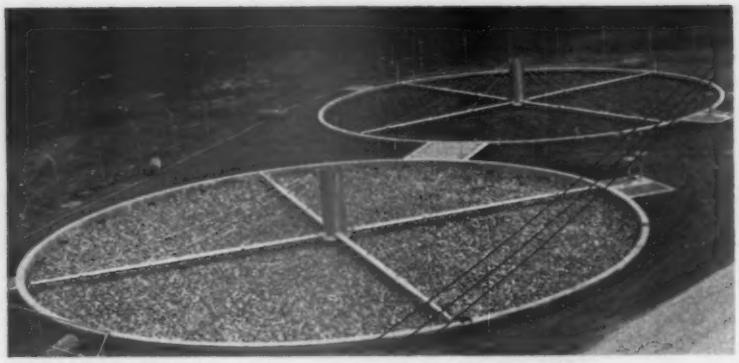
EDITOR NOTE: It is unusual for an engineer to have the opportunity to design and supervise the construction of a completely new sewer system and treatment plant. Such was the case for the East Ridge, Tenn. works, the design and construction of which is described in this paper. About 94 miles of sewer were installed under difficult soil and ledge conditions and to install the treatment plant required excavation of 2000 yards of rock.

■ EAST RIDGE, Tenn. has been called the fastest growing community in Tennessee. It has developed into a town of approximately 18,000 inhabitants over a relatively short period of time. Between 1930 and 1940 East Ridge had a population of 2000 to 3000 persons, whose homes bordered both sides of Ringgold Road, U.S. Highway 41 between Chattanooga and Atlanta. A rapid commercial development along this highway with attendant spreading housing subdivisions has accounted for this rapid growth since 1940. The boundaries of the Town are along the Tennessee-Georgia State lines on the South and the City Limits of Chattanooga on the West and Northeast, the area consisting of a triangular shaped tract of land of approximately 4000 acres.

Annexation of this area to the City of Chattanooga has been discussed pro and con by both municipalities but the East Ridge inhabitants have clung fast to their independence. Gas tax refunds from the State have made possible the surfacing of the streets and maintenance of drainage and a tax rate of 16 cents on a $17 million dollar evaluation had provided sufficient revenue for the Town's other services up to 1955.

The general area is limestone overlaid by dense residual clay containing a substantial amount of chert. Septic tanks became a serious public health problem as the Town grew and commercial developments were expanded. Faced with this sanitary problem in 1953 the Town Commission engaged engineering services to prepare a report and sewerage plans, funds for which were secured through an advance by the Bureau of Community Facilities of the Housing and Home Finance Agency of the U.S. Government.

Plans included provision for a pumping station and an outfall sewer



TRICKLING FILTERS

to the Ctiy of Chattanooga's Brainerd Treatment Plant, enlargement of which is proposed. East Ridge sewage would have been treated there for a consideration based on volume and strength of the sewage.

This program for alleviating the progressively worsening sanitary conditions was submitted to the voters for approval in the early part of 1953 on a revenue bond basis, charges being allocated on the amounts of water used. The referendum failed to receive a majority vote and the project was temporarily suspended until public demand for it was more in evidence. Eventually the problem reached the critical stage at which the Hamilton County Health Department notified the East Ridge Town Officials that failure to provide adequate sanitary facilities would make it impossible for that Department to approve building permits for construction of new commercial buildings along Ringgold Road.

The public gradually recognized the serious effects of this problem and in 1955 the Town Commission and Town Manager prepared a program for obtaining sanitary sewerage and sewage treatment plant facilities for the town. In 1956 the same engineers were engaged again to bring the original plans up to date since the Town had grown substantially in the meantime; prepare plans for a sewage treatment plant and cost estimates of the revised project to be built in five contracts over a period of approximately 4 years. These engineers were also engaged to supervise and inspect the project construction.

The Town of East Ridge had always operated on a "pay-as-you-go" or cash basis and had never sold bonds for financing any of its improvement projects. The Town was restricted by charter from providing many normal municipal services such as fire and police protection, operation of schools, collection of garbage, etc. The maximum tax rate for municipal services had been established in the charter at 20 cents per 100 dollars of assessed valuation. However the charter also provided that additional taxes could be levied for purposes of meeting bond obligations when bonds are issued for specific public works projects. It was therefore expedient to receive authority from the voters to finance, construct and operate a sewerage system and a sewage treatment facility. The Town is also unique in another respect in that it had been operated on such a sound and conservative fiscal basis that it had accumulated an unencumbered cash surplus of some $200,000 that could be allocated to the sewerage construction fund.

Financing arrangements had been completed with Equitable Securities Co. in Nashville, Tennessee by 1956 with the Town pledging general obligation bonds by an increased tax rate of 64 cents per hundred dollars of assessed valuation. This was overwhelmingly approved by the voters in a referendum in March of 1956. The project was estimated to cost $4.25 million dollars, broken down as follows:—

Treatment Plant, $725,000; Sewerage, $3,000,000; Engineering, Inspection, etc., $525,000; Total, $4,250,000.

In 1957 the U. S. Government provided a grant of $250,000 under the Federal Water Pollution Control Act, Public Law 660, for construction of the treatment plant and outfall sewer, bringing the estimated cost of the entire system to the Town to $4.0 million.

Sewerage

The sewerage project is one of considerable magnitude as evidenced from the fact that approximately 94 miles of sewers will have been laid when the project is completed. A breakdown of estimated quantities is given in Table I. It is a rare occasion when engineers have the opportunity to design a completely new sewerage system of this scope and magnitude. The town desired the system to be first class in every respect requiring a minimum of maintenance. It was also anxious to keep operating and depreciation costs as low as possible at least during the life of the bonds, which are to be retired over a period of 30 years, and during the time that the town will be maturing through the "growing pain" stage of its history.

The sewer system was designed to serve the populated areas and be of such capacities and arrangement that new developments can be sewered and tied in without duplicating any work. Even though the topography is rolling, the entire system is laid out for gravity flow. Specifications provided for all pipe under 21 inches in diameter to be extra strength vitrified clay pipe with bitumastic joints. Larger pipe were specified to be reinforced concrete culvert pipe with rubber gaskets. During the progress of the work, positive friction type gasketed joints were accepted as equal to bitumastic joints.

Sewer construction is expensive in this area due to the extreme narrowness of streets in the older sections of town, making it difficult for efficient operation of heavy equipment, backfilling and cleanup operations. Extensive, hard, cherty material, requiring blasting to loosen before digging with backhoes, have prevailed in the higher areas. Rock has been encountered at the bottom level of trenches over most of the low areas making it unfeasible to utilize trenching machines. This has necessitated the placement of fine crushed stone bedding under much of the pipe laid to date. The Town approved an ex-

penditure for detailed engineering inspection of all the construction work. All of the measures taken appear well justified because infiltration tests made to date show substantially less than the specification maximum tolerance of 500 gallons per 24 hours per inch of diameter per mile of sewer.

It had never become necessary or feasible for the Town to adopt and enforce a plumbing code because of the limited charter. However when the sewerage project was started, a code had to be written and placed into effect. The Town Manager and Town Attorney prepared a modern code designed to assure that all connecting sewers would be water-tight and safe from clogging by tree roots and other foreign matter between buildings and the sewage collection system. This code was approved by the Town Commission and an ordinance providing for its enforcement was adopted.

Being aware of the problems of heavy ground water infiltration and house sewer stoppages that other towns have encountered from outmoded regulations, the code provides that only cast iron soil pipe with lead joints or vitrified clay pipe with positive friction type coupling may be used for house connections. The Town employs a full time inspector to check and test these lines before they are approved for use by the property owners. East Ridge has the distinction of being one of the first towns in the country to adopt this type of code.

The first sewerage contract of approximately $1.17 million for about 29 miles of sewers was let on June 29, 1956 and work was commenced on July 15, 1956. The contract covered sewers in the lowest areas and along the commercial development on Ringgold Road. In this contract were temporary septic tanks with chlorination facilities. The second sewerage contract for approximately 18 additional miles of sewers was let July 23, 1957 for $659,000. A third contract for approximately $1.13 million was let April 10, 1958 for approximately 30 miles of sewers. Of these three contracts let to date, the first and second are complete and the third will be completed by July 1959. A fourth and final sewerage contract for approximately 17 miles of sewers is expected to be let in the early spring of 1959. Work on all phases of the East Ridge sewerage project is scheduled to be completed early in 1960.

DIGESTERS and Digester Control Building

Of the sewerage work let to date, pipe sizes range from 8 inches to 36 inches. The average cost of sewerage laid, including wyes, stubs, manholes, earth and rock excavation, crushed rock bedding, backfilling, private property and street repairs and other appurtenances is $38,440 per mile of pipe laid, without differentiating between the various sizes and types of pipe.

The Sewage Treatment Plant

East Ridge is primarily a residential and commercial community. There is no reason that would justify industrial development of the area. Land occupancy, based on similar developments, was anticipated on the basis of 10 persons per acre, for an ultimate population saturation of 40,000 persons. Based on the past and a rational projection of the future growth, 40,000 persons can be expected to populate East Ridge by year 2000. The estimated 1957 population was 18,000.

Excellent water records were obtained from the City Water Company, a public utility serving Chattanooga and East Ridge. These showed a steady increase in average domestic water consumption per capita from 42.8 gallons per day in 1950 to 53.4 gallons per day in 1955. The corresponding average water use in Chattanooga is 71 gpcpd and after sewers are in operation at East Ridge it is believed that a similar figure will be obtained there ultimately. Allowing for present water use based on an 18 hour period, an average sanitary sewage flow rate of approximately 75 gpcpd would result. The treatment plant was therefore designed for 100 gpcpd to allow for increased water use, unbalanced loading and normal infiltration. Initial design provides facilities for 20,000 persons with provision for expansion to double this amount.

Because the ultimate receiving stream, South Chickamauga Creek, can reach low flows of 60 c/f, the requirements for the sewage treatment plant were manifestly for complete treatment. The plant is located at the lowest conveniently available area on the right bank of Spring Creek, a tributary of South Chickamauga Creek. As designed this facility is a single stage, high rate, trickling filter plant. A main control building houses the wet well that receives raw sewage from two outfall lines. The raw sewage passes through a comminutor before entering the wet well and is taken from the wet well by primary or raw sewage pumps of which there are four having capacities respectively of 0.75, 1.5, 2.25 and 4.0 million gallons per day. Also housed in the main control building are a digested sludge pump, vacuum filters for dewatering sludge, chlorination facilities, laboratory, office and wash room.

From the primary pumps, sewage is pumped to two primary clarifiers each of which is 18 feet wide by 70 feet long by 9 feet average water depth. These have a detention rate of 2 hours, an overflow rate of 800 gallons per square foot per day and ef-

fluent weirs for flows not to exceed 1500 gallons per linear foot per day. The effluent from the primary clarifiers passes by gravity to 2 high rate trickling filters, each 65 feet in diameter by 6 feet deep. They are designed for an average BOD loading of 1.55 pounds per cubic yard and an average loading of 13.3 million gallons per acre per day. Minimum hydraulic loading is maintained at 10 million gallons per acre per day. The maximum loading is 30 million gallons per acre per day. After leaving the trickling filters, the effluent flows by gravity to the secondary pumping station which houses four pumps having the same capacities as the primary pumps. These pumps lift the filter effluent to two circular secondary clarifiers each 40 feet in diameter and 9 feet deep. They have a two hour detention period and an overflow rate of 800 gallons per square foot per day, with an effluent weir around the entire circumference of the tank.

From the secondary clarifiers the effluent passes all or in part, either to a Parshall flume and thence to a baffled chlorine contact tank 17 feet wide by 23½ feet long by 7 feet water depth which provides 15-minute detention, or back to the wet well in the primary building for recirculation to maintain rated pump capacity. After the effluent passes through the chlorine contact chamber, it flows by gravity to Spring Creek Branch of South Chickamauga Creek. Provision is also made at the outlet end of the chlorine contact chamber for diversion directly to South Chickamauga Creek in the future, a precaution taken to meet ultimate conditions when the relationship between flows in Spring Creek Branch and total effluent become such as to require the effluent to be piped to the larger water course. When this becomes necessary, a new outfall sewer will be constructed from the chlorine contact chamber to South Chickamauga Creek, a distance of 3000 feet.

Sludge is taken from the primary and secondary clarifiers and pumped to two floating cover sludge digestion tanks, each 40 feet in diameter by 23 feet side water depth, having sloping bottoms. Between the tanks the sludge operations building is located. It houses the heat exchanger, sludge pumps, controls and gas facilities. Sludge is drawn from the sludge digestion tanks and pumped to the second floor of the main control building where a vacuum type sludge filter with nominal effective surface area of 100 square feet filters the sludge at a rate of 432 pounds per hour. Filtered sludge is carried by belt conveyor to an overhead hopper from which it is loaded to trucks by gravity to be hauled away and disposed of. Sludge conditioning with ferric chloride and lime is provided for the sludge entering the filters.

The chlorine room is separately housed on the first floor of the main control building. Two 200 pound chlorinators with automatic proportioning equipment dispense chlorine from this room through rubber-lined pipe to provide pre-chlorination at the primary clarifiers, chlorination ahead of the filters, and post-chlorination at the chlorine contact chamber. Chlorinators are fitted for manual or automatic operation. Chlorine is brought to the plant in 2000 pound drums, unloaded by an overhead trolley hoist and moved thereby to the chlorine room, where space is provided for two tanks on the scales. Additionally racks are provided outside for the storage of two additional cylinders.

TABLE I

Principal Quantities—East Ridge Sanitary Sewerage Project

Pipe Size (inches)	Linear Feet
8	432,983
10	22,291
12	10,899
15	11,362
18	7,000
21	5,744
30	1,237
36	5,933
Total all Pipes	497,449

Other Quantities	
Item	Quantity
Manholes (each)	2,000
Wyes (each)	12,500
Rock Excavation (cu yds)	30,000
Crushed Stone Bedding (cu yds)	20,000

The plant is designed and arranged for easy and economical operation, with adequate provision for convenient enlargement at minimum reasonable costs. Since it is located near a residential area, the plant has a pleasing appearance and every possible feature has been included to preclude the development of odors and other nuisance problems about the area. The principle facilities for odor control are vacuum filtration of the digested sludge, pre-chlorination, post-chlorination, chlorination ahead of the filters and continuous dosing of the filters through recirculation of the secondary clarifier effluent during periods of low flows. A big item in the treatment plant cost has been the excavation of over 2,000 cubic yards of rock.

The plant was put into operation the first week in November 1958 and has operated continuously and satisfactorily since that time.

General

The citizens of East Ridge are justly proud of the progress made on the sewerage work project. They are availing themselves of the opportunity to connect on and enjoy the benefits of the system as rapidly as sewerage is available in their locality. It is interesting to see the improvement in the appearance of property and attitudes of the residents in the area as the sewerage facilities are placed in use. In a statement at the dedication of the treatment plant, the Mayor of East Ridge expressed the public sentiment of the Town toward its responsibility to its citizens and neighbors when he said, "This sewerage system and sewage treatment plant had to be built and has to be paid for."

One unique innovation of this system is an interchange agreement with the City of Chattanooga. Portions of Chattanooga are located in the East Ridge drainage area and vice versa. By agreement, each town is compensated for the sewage the other discharges into its respective system in accordance with volume of water used by each individual user being served.

A method for reducing the cost of treatment plant operation plus reclamation of waste land is presented in . . .

Utilization of Liquid Sludge

by ROBERT C. MERZ*
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University of Southern California
Los Angeles, California

EDITOR'S NOTE: The high cost of fertilizer production from sludge precipitated an investigation by the City of San Diego assisted by the faculty of the Department of Civil Engineering, University of Southern California into the application of liquid digested sludge onto waste land both for disposal and soil improvement. Loadings from 10 to 100 tons of dry solids per acre of sludge, the additions of commercial fertilizers, and leaching with local water before planting were investigated as to their effect on the quantity of barley which the plots could produce. The results have lead the city to abandon their fertilizer production equipment.

■ THE CITY of San Diego, California operates a primary type sewage treatment plant. The disposal of digested sludge at this plant has been effected through elutriation, vacuum filtration, and other normal steps attendant to the production of fertilizer. Because of the high cost of this method of sludge disposal, the City was anxious to explore the feasibility of developing a less expensive but equally beneficial method. It was believed that if the digested sludge could be successfully applied to existing waste lands owned by the City without adverse effect, savings in water requirements on areas developed for public use might be made and increased revenue might be obtained from those improved lands released for agricultural purposes.

An investigation was accordingly planned for the purpose of obtaining answers to as many as possible of such questions as:

1. Will there be any deleterious effects on the soil, or interference with plant growth, as a result of the chemical properties of the sludge?
2. What are the most economical methods of handling and application of the material to the various types of soils to be encountered?
3. What are the optimum amounts for various types of soil?
4. Are there any serious problems of nuisance resulting from odor, flies, dust?
5. What are the beneficial effects of the application from the standpoint of increased water retention and the addition of plant nutrients?

*Contributing Editor, WATER & SEWAGE WORKS

Test Site

A 4-acre test plot in the Tijuana River Valley was selected for initial sludge disposal because of its small size, proximity to the disposal plant, cooperative interest of the farmer who leases this land from the city and the information to be obtained by adding sludge to a virgin waste soil. The plan was to spread liquid sludge on the 4-acre test plot at various loadings and then evaluate benefits by cropping the area. San Diego sludge solids are digested at 85° for 30 days in a two-stage digestion system. The mineral content of a particular sludge is dependent upon the derivation of the sewage solids. The character of solids from the San Diego primary treatment plant would be expected to differ from those derived from an activated sludge plant or a trickling filter plant. The average chemical analysis of the sludge used in this work is presented in Table 1.

A survey party was sent into the field to prepare a topographic map of the test site. The site was then graded to provide a uniform slope of approximately .003 from the southeast to the northwest. Dikes 18 inches high were constructed around the periphery of the field and were used to divide the test site into 5 major areas, A, B, C, D1, and D2, all as shown in Figure 3. Three of the main sections were further subdivided by dikes into spreading basins, each approximately 20 ft wide.

A type of trailer-truck combination was used for the hauling of the liquid sludge. This single unit was used for the entire test hauling operation, as its 6000 gallon capacity proved adequate for the available sludge. Liquid sludge was hauled to the test site and spread as directed from July 28 through October 10, 1955, excepting Saturdays, Sundays, and holidays.

There were no major difficulties encountered in the handling of the sludge. Sludge was easily pumped from the digester into the hauling units through a pipe line fitted with a telescoping sleeve at the discharge end. Discharge at the site was by gravity through a 4-in. discharge line.

The dry solid content of the sludge varied from 4.48 to 7.98 percent, and averaged 6.48 percent. In Table 2 is summarized the data concerned with the loading of the several strips. It will be noted that the loadings ranged

LOADING OF SLUDGE was accomplished by a telescoping pipe.

from approximately 10 to 100 tons of dry solids per acre, with one portion of no loading serving as a control area.

The haul of liquid sludge to the Tijuana test site was halted on October 10, 1955. The site was permitted to dry until November 9, at which time the site was plowed and generally made ready for planting. In addition, to compare conventional fertilization with the benefits obtained only through the use of liquid sludge, a 1.4-acre portion of the site cutting across all control and variously loaded areas was treated with 425 pounds of ammonium sulphate, amounting to 40 pounds of nitrogen per acre.

The test site was sown with barley on November 30, 1955. The harvest date was April 12, 1956, providing a growth period of 144 days. During this time, 1.25 inches of rainfall occurred, chiefly on December 3 and 4, and January 26 to 31. An additional 16.5 inches were applied in 3 irrigations.

Results

Prior to and after the addition of sludge, arrangements were made for collecting samples of the soil at 3-inch, 9-inch, and 4-foot horizons. These soil samples were subjected to physical analyses, the results of which indicated that the soil was predominantly sand.

Permeability tests of the soil before and after the sludging were made. Six measurements over a period of 5 months prior to sludging indicated an average percolation rate of 16 inches per hour. After sludging, permeability tests indicated an increase in the percolation rate to 24 inches per hour.

It was apparent from soil densities taken before and after sludge application that the sludge did not appreciably change the density.

The average organic matter content of the soil at the 3-in. level increased from 3.6 percent prior to sludging to 7.2 percent after sludging. Similarly, the average organic matter content of the soil at 9-in. level increased from 2.92 percent prior to sludging to 5.16 percent after sludging.

The percent moisture of the soil samples following spreading showed increases up to 17 percent. These values are indicative of the water that percolated into the soil from the sludge. No rainfall occurred, and no other water was applied to the field during this time. These high moisture contents correlate with the increase in conductivities of soil extracts. It was found that there was an increase in the salinity of the surface soil because of the concentration of ions resulting from the evaporation of moisture from the liquid sludge applied to the land. This increase in total dissolved solids was shown by the increase in conductivities from a range of 0.079 to 0.620 millimhos per cm prior to the application of the liquid sludge to a range of 0.55 to 5.80 millimhos per cm in similar soil samples after application and drying of the sludge.

The extensive mineralization found in the soil indicated that the soil had a high salinity hazard. This was confirmed by difficulties encountered in actual germination and growth of the barley crop. It should be noted that the mineralization of the soil was not due to the presence of the organic material in the sludge, but rather due to the salinity content of sewage effluent applied to the soil should cause the same mineralization to take place. There was no accompanying increase in the boron concentration, and this fact would indicate that boron was not a factor in the growth behavior of the test crop.

The addition of sludge to the soil increased its saturation percentage, or moisture holding ability. The composited samples of soil from the test plot receiving 100 tons of dry solids per acre exhibited an increase in saturation percentage from 27 to 50, with lesser increases for lower loadings. The conductivity measurements, as well as the exchangeable sodium percentage, indicated that the soils of the test area, following application of sludge, could be classified as saline, and would require leaching before being used for agricultural purposes. No alkali problem existed.

The pH of the soil of the test plots was obtained. It was found that the highest pH of 7.8 occurred in the test area where the greatest sludge loading was placed. The lowest pH of 6.4 was noted at the point of application where the least sludge loading was placed.

Biochemical analyses of the soil at four of the test points in the field were made before and after sludge application. Ten grams of soil were added to 100 ml of distilled water and the BOD of the resulting solution determined. The BOD before sludge ap-

TABLE I
ANALYSIS OF DIGESTED SLUDGE, SAN DIEGO

	Prior Average	Average During Spreading
Total Dry Solids	3.44	-
Grease	11.15	-
Fatty Acids	24.23	-
Chlorides	0.75	0.87
Total Nitrogen	2.73	2.78
Phosphorus as P_2O_5	4.78	4.70
Sodium	1.07	0.56
Potash as K_2O	0.83	-

All results in percent, on a dry basis

plication ranged from 2.4 to 18.4 ppm, without much correlation existing between the various depths. After sludge application, the BOD ranged from 2.3 to 30.3 ppm, and in general the greatest BOD was exerted by the surface soil. It is evident that the well-digested sludge created no undesirable anaerobic condition in the soil of the test plot.

Following sludge application and drying, the field was prepared for planting. No rainfall occurred and no attempt was made to apply any well water for the purpose of leaching the soil before planting. Routine visits were made to the test site in order to observe the growth of the newly sown barley. There was poor germination of the seed, and growth was very spotty at certain locations. The crop developed best in areas where there was minimum mineralization. Strips of more abundant and taller barley were observed on the dikes separating the various loaded beds. These dikes received only dried sludge from the discing operation, while the adjacent beds absorbed the water of high salinity of the sludge. Typical soil tests from areas of poor and good barley growth revealed conductivities of the soil extracts to be approximately 2.0 millimhos per cm in the area of poor growth and 1.34 millimhos per cm in the area of good growth. Sodium percentages for the two samples were 30 and 37, respectively.

The control sections of the test plot where no sludge had been applied provided poor germination and poor growth, indicating that the barren sandy soil, as expected, would not support a good growth of barley.

Only 1.5 inches of added irrigation water were applied during the first 2 months following planting. The latter, larger applications of well water could not overcome the early lack of adequate leaching water. The quality of the highly saline well waters in the Tijuana region indicate that relatively large volumes would be required for leaching objectionable soil salinities to tolerant levels. The most significant fact learned from these tests is that it is imperative that adequate leaching either by rainfall or irrigation water be provided to remove the high salinity concentrations.

The first barley crop was harvested on April 12, 1956, after 144 days' growth. Typical cuttings from the several plots were gathered and weighed. Table 3 summarizes these data. The results show that all sludge applications improved the yield over that from the area of no loading. Cuttings from areas of 10 tons of dry solids per acre loadings gave the most consistant results, while cuttings from the areas of 50, 75, and 100 tons of dry solids per acre gave the greatest variations. The weight of cuttings from sludge application of 50 tons of dry solids per acre was the greatest but no evidence exists that with proper loading and subsequent leaching 70 or 100 tons dry solids per acre would not be equally satisfactory for a sandy soil such as existed in the test site.

UNLOADING at the test area by gravity.

The data also indicate that the addition of a commercial fertilizer (ammonium sulphate) had no consistent effect on the growth of the barley at the higher loadings.

In July, 1956, the test site, without further sludge additions, was prepared for a second crop. Young tomato plants were set out, and their growth was dependent upon the residual sludge in the soil from the first application in which the barley had been raised. The tomato crop was reported to be far superior to those picked from plants grown in the area where sludge had not been used, even though supplemental commercial fertilizer had been used on the entire site.

Second Application

In preparation for a second sludge application at high rates, the test site was scraped with a bull-dozer and top material so removed was used to increase the height of the berms. There is little doubt but what much of the sludge applied early in the first year of operation found its way into the berms.

The soil samples taken following berming of the field in February, 1957, were analyzed. The per cent moisture ranged from 20.27 to 2.71 and was consistently higher than it was in November, 1955, shortly after the original application of sludge. The per cent organic matter ranged from 0.42 to 6.70 and was consistently less than it was at the prior date as expected as a result of the method of site preparation. The mineralization,

TABLE 2
SLUDGE SPREADING DATA

Plot	Total Tons of Dry Solids Applied	Area of Plot in Acres	Average Loading Tons Dry Solids Per Acre
A	59.8	1.0625	53
B	34.8	1.2741	28
C	50.8	0.52	98
D1, 1-6	64.33	0.846	76
D2, 7	1.53	0.101	15
D2, 8	0.81	0.0778	10

as measured by conductivity, ranged from 0.15 to 0.69 millimhos per cm, and indicated that the conductivity had returned to values existing before the original application of sludge. When compared with values obtained in April, 1956 or approximately at the end of the first growing season, the conductivities were found to be less and showed the effect of irrigation with local water during the raising of a crop of tomatoes. The conductivity of the local water used was 3.0 millimhos per cm. Further affecting the reduction in conductivity was the rainfall of January, 1957, of 4.35 in.

As previously described, during the 1955-56 tests, sludge loadings as high as 100 tons of dry solids per acre had been used. At that time, it was determined that these high loadings did not have any ill effects upon the growth of plants provided there was suitable pre-irrigation and leaching of the soil to remove excess dissolved solids. In February, 1957, loadings from 60 to 300 tons of dry solids per acre were applied to portions of the site previously sludged to determine if it would be satisfactory to use land areas for continued disposal of sludge without resultant problems. The portions of the site receiving the second sludge loading are designated as T1, T3, T6, T8 and the quantity of sludge applied is shown in Table 4.

The termination of this project prevented the continuation of observations on the results of such loadings. However, thus far there is no information to indicate that any serious problem has developed as a result of continuing such high loadings on the same site. At the close of project activities, June 30, 1957, the second sludge application had dried within the test area and the cooperating farmer had plowed the sludge into the soil. As described, the sludge was applied to the land, allowed to dry for a period normally involving 30 days, and then plowed back into the soil. No public health problem or nuisance developed. No significant fly problems developed. However, large numbers of small flies were observed. These flies occurred during the harvesting operations associated with the packing of corn and other vegetables. They were localized on sludge areas that were wet but just free of surface moisture. The flies disappeared as soon as the surface dried. Careful investigation has not indicated any correlation between the sludge spreading operation and the presence of these small flies. When packing operations were completed near the sludge disposal site, no further flies were observed.

The odor of well-digested sludge is tarry, but inoffensive. It varies slightly in its characteristics. There was a slight musty odor present when the sludge was spread upon the soil. After a period of 2 to 3 weeks, when the sludge had almost dried, the odors disappeared completely.

The local health department collected samples of the well waters adjacent to the test site. The water samples from most of the wells were negative. These data are inconclusive; however, since many of these wells are used only intermittently it is believed that coliform counts are directly related to sanitary conditions.

TABLE 3
BARLEY GROWTH DATA

Plot	Station	Approx. Sludge Loading, Tons D.S. Per Acre	Sludge Only Lbs. (Dry) Per 25 Sq. Ft. Station	Sludge Only Lbs. (Dry) Per 25 Sq. Ft. Average	Sludge + Nitrogen Lbs. (Dry) Per 25 Sq. Ft. Station	Sludge + Nitrogen Lbs. (Dry) Per 25 Sq. Ft. Average
A	1	50	4.94		4.83	
	2	50	6.59		8.04	
	3	50	4.33			
	4	50	9.65			
	5	50	7.15			
				6.53		6.44
B	1	25	2.45		4.82	
	2	25	3.61		6.93	
	3	25	3.32			
	4	25	3.35			
	5	25	4.98			
				3.54		5.88
C	1	100	6.45		2.75	
	2	100	4.49		2.28	
	3	100	2.77			
	4	100	5.52			
	5	100				
				4.81		2.52
D	1	75	6.97		2.55	
	2	75	2.84		3.32	
	3	75	2.44		8.80	
	4	75	2.88			
	5	75	3.55			
				3.73		4.89
E	1	10	4.38		5.58	
	2	10	4.97			
	3	10	4.88			
				4.74		5.58
C	1	0	1.92		2.00	
	2	0	1.67		2.81	
	3	0	1.65			
	4	0	1.69			
	5	0	2.86			
				1.96		2.40

Costs

The processing of sludge at a treatment plant represents a significant amount of the total expenditure for sewage treatment. The San Diego installation is typical of the sludge handling procedure utilized at similar large plants. The settled sludge from this primary treatment works is introduced into the primary sludge digestion tanks where it is held at 85 deg. Fahr. for a period of about 15 days, and then the sludge is transferred to secondary digestion tanks for an additional 15-day period. The sludge was formerly elutriated and then dewatered on vacuum filters and heat dried. The sludge was then packaged and sold under private contract to a fertilizer firm which distributed it to agriculturists as a soil conditioner.

The estimated cost at San Diego for such processing of the digested sludge during the year 1953-54 was reported to be $39.15 per ton of dry solids handled. Approximately half of this represents labor costs. The cost of alternative disposal of the liquid digested sludge is dependent upon (1) the concentration of dry solids present in the liquid sludge, (2) the distance which the sludge must be transported, and (3) incidental expenditures that may be in-

curred. The cost for hauling sludge of an average of 6.48 per cent solids by private contract from the treatment plant to the Tijuana site is now 3.7 mills per gallon. This amounts to a total cost of $23.03 per ton of dry solids, including all overhead costs.

The change-over from fertilizer production to land disposal of the liquid sludge has thus resulted in a cost reduction of $16.12 per ton of dry solids, or approximately $48,400 per year. Whereas 31 per cent of the plant budget originally was allocated to the fertilizer operation, now but 11 per cent is allocated to sludge disposal.

Further Investigation

The obtaining of quantitative information on plant growth requires years of carefully carried out tests in what agriculturists commonly call "replicated plots". Such plots involve the multiple planting of certain plants under uniform conditions of soil, fertilization, and irrigation. Replicated plots were established on the grounds of the San Diego Sewage Treatment Plant so that plant personnel could conveniently supervise the spreading of the sludge, the necessary planting, and the sampling of the plots.

The selected location for the replicated plots was an area adjacent to the primary clarifiers. Surface debris was first removed, and the area was then graded. A hand cultivator was then used to loosen the soil. Through the construction of a system of dikes, a block of 25 replicated plots was formed. Each plot measured 10 ft by 10 ft. In preparing the plots, it was found that the soil conditions were extremely variable since the area contained dredged soils from the bottom of the bay.

Various amounts of sludge or ammonium phosphate (16-20) was then applied to the plots in a planned pattern. A hand cultivator was then again employed to mix the sludge and fertilizer with the soil. Leaching was accomplished through the application of 6 in. of local water. Commercial fertilizer was not applied to any of the plots until after leaching.

Analyses were performed to determine the conductivity and percent sodium of soil samples taken from within the replicated plots, both before and after sludge application and leaching. In summary, it may be stated that the application of sludge, followed by leaching, brought about a more uniform soil conductivity than existed before leaching. The maximum at the 3-in. level was 3.1 millimhos per cm, and at the 5-in. level 6.9 millimhos per cm.

TABLE 4
SUMMARY FOR SLUDGE SPREADING DATA AT TIJUANA TEST SITE

Plot No.*	Area in Acres	First Sludge Loading July-August, 1955		Second Sludge Loading February 1957		Total Sludge Loading	
		Dry Solids Applied		Dry Solids Applied		Dry Solids Applied	
		Tons**	Tons per Acre	Tons	Tons per Acre	Tons	Tons per Acre
T-1	0.4	39.0	98	124.7	311.8	163.7	410
T-3	0.4	30.4	76	79.1	197.7	109.5	275
T-6	0.4	11.0	28	24.8	62.0	35.8	90
T-8	0.6	33.7	56	87.7	146.2	121.4	200

The replicated plots were then planted with barley at a rate of 80 lb of seed per acre, on November 13, 1956. The growing period was approximately 4 months. About 19 in. of irrigation water were applied, of which 13.6 were derived from the local supply, 5.4 from rainfall.

The havesting procedure used was to cut a 5 ft by 5 ft portion from the center of each of the 25 plots. This was done to avoid the influence of one plot on the other along the common boundaries.

The cut samples were weighed wet and then again after drying, and moisture contents were computed. In general, the best growth was obtained with commercial ammonium phosphate (16-20) applied at a rate of 400 lb per acre. Almost as good growth was obtained with the sludge loading rate of 100 tons of dry solids per acre. It was noted also that the use of 25 and 50 tons of dry solids per acre resulted in improved plant growth.

As a result of the replicated plot tests, no definitive, quantitative information can be presented. However, one of the clear facts that has been developed is that high dosages of sludge fertilizer, or sludge soil conditioner, do not in any way appear to harm barley growth. The amount of nitrogen as N added by sludging was approximately 80 times the amount added by using commercial fertilizer. The amount of phosphorus as P_2O_5 added by sludging was approximately 140 times the amount added by using commercial fertilizer. Additional replicated plot tests would have to be repeated over a period of years in order to establish additional basic information.

Summary

The value of organic matter as humus in the soil for maintaining and storing moisture is well known. The results of the San Diego work have strengthened and confirmed the value of sludge reclamation. The City of San Diego has found land disposal to be a satisfactory and practical method of utilizing the liquid digested sludge produced at its treatment plant. Sludge conditioning and drying facilities have been shut down, and all the sludge produced now is being utilized for the improvement of soils. In summary, it is believed that the San Diego liquid sludge disposal operations have shown that

(a) it is possible to reclaim waste land for agricultural purposes with the application of liquid, digested sludge of reasonable solids concentration at a cost less than that for producing a dried sludge product;

(b) it is possible to apply sludge loadings as high as 100 tons of dry solids per acre without in any way impairing crop growth;

(c) it is possible to apply sludge loadings as low as 25 tons of dry solids per acre to produce crop growth comparable to the growth achieved by the use of commercial fertilizer at conventional application rates;

(d) it is possible to grow at least a second, superior crop because of the residual fertilization afforded by an initial sludging at a rate as low as 50 tons of dry solids per acre;

(e) it is possible to avoid all serious sludge handling or nuisance problems.

How to prevent that sewer break at midnight on a rainy Saturday night is discussed in . . .

A Sewer Maintenance Program

by AL VOLPE
Commissioner of Streets
and Sewers
Borough of Wilmerding, Pa.

EDITOR NOTES: "Although a Sewer is buried, it should never be forgotten". With this as his motto Mr. Volpe presents a program which begins with the construction of the sewer, includes legislation to protect it and provides continuous inspection and cleaning. Among the important items discussed are the relative merits of engaging a sewer cleaning firm on contracts vs cleaning with sewer department crews.

■ THE PROPER time to begin forestalling trouble is before a sewer section is laid. Proper installation can go a long way toward guaranteeing years of trouble free service. One often overlooked item is the sewer gradient; if inadequate, it will prevent the flows from reaching a self-cleansing velocity. Grades listed in Table 1 should be considered minimum.

Other sources of potential trouble can be eliminated by making sure that the bottom quadrant of the pipe is fully and uniformly supported. Where the floor of the trench is not sufficiently stable or firm to prevent vertical or lateral movement of the pipe after installation, a supplementary foundation should be provided. The simplest type of foundation is a layer of broken stone, sand, cinders, or gravel, laid on the floor of the trench. Proper support around pipe bells is particularly important. Excavations of the bells should be as small as possible.

Pipe trenches should be of minimum width because, as the distance between pipe wall and trench wall increases, the load on the pipe increases. Thorough tamping of the backfill is also crucial, for it prevents lateral displacement of the pipe and assures uniform load distribution.

Pipe joints are among the most critical points in any sewer system. Jointing compounds must remain water-tight even under deflection, must resist roots, corrosive wastes and gasses. Quality workmanship is imperative.

Other sources of trouble include the following: junction chambers that have back-water areas of low velocity; storm water overflows accessible to vandals; catch basins of inadequate size; pipe laid in industrial and commercial areas which is unable to resist the deterioration produced by corrosive wastes; manholes spaced more than 350 feet apart; and diversion and regulator devices that are complicated in design and difficult to reach.

Sewer Ordinances

Those in charge of sewer maintenance activities can reduce their workload considerably by pressing for ordinances with sufficient "teeth" to control sewer usage. Such legislation should accomplish very definite results: it should restrict the location of poplar, willow, and other trees that can cause root stoppages; it should ban connection of down-spouts to sanitary sewers unless the system is designed to handle stormwater also; it should provide for inspection of house service lines by competent personnel, and describe in detail the kind of inspection needed; it should require suitable preliminary treatment facilities for the greasy, corrosive, or high solid wastes of such commercial and industrial establishments as restaurants, auto service stations, dry cleaners, and packing plants; and one thing very often ignored, it should include stern penalties for vandals who damage the sewer system, whether out of negligence or pure malice.

Table 1

Diameter of Pipe (inches)	Fall in ft/100 ft. of sewer
6	0.65
8	0.40
10	0.29
12	0.22
15	0.16
18	0.12
24	0.10
28	0.08
36	0.04

Legislation, of course, is a long-term maintenance aid at best. The biggest single problem facing those charged with keeping the sewers operating efficiently is how to forestall, before it becomes serious, trouble that may already have started to develop in an existing system. Basically, the answer is a periodic inspection program.

The entire sewer system should be inspected at least once a year. Those sections that have proven troublesome —or are capable of providing troublesome—should be checked more often. A sewer laid on a flat grade, for example, will bear careful watching, for solids are likely to settle out and cause clogging.

Among the hazards to look for, especially in industrial or commercial areas, are noxious or flammable gases and oxygen deficiencies. A variety of detectors and indicators are now

available for this work. Inspectors should also observe the odor, color, pH, and temperature of the flow in industrial-commercial areas, for these are clues to the presence of improperly treated wastes.

Sluggish flows at any manhole usually indicate a blockage which may be due to roots, fungus, sediment, pieces of lumber or other foreign objects, or any of a number of other types of obstruction. Flushing the sewer with a fire hose is the easiest, but also the least effective means of removing the trouble. A wide variety of hand and engine-powered equipment is on the market, which is generally much more successful in ridding the sewer of blockages.

Contract Cleaning

If, however, as is often the case, a sewer system hasn't been cleaned in years, and an excessive number of complaints are heard from users, calling upon an outside sewer cleaning contractor will probably be the quickest, most efficient method of restoring the system to peak operating efficiency.

The contractor's equipment is generally more powerful than anything obtainable on the market, and his personnel, because they are engaged in this work full-time have more specialized experience than the typical municipal sewer maintenance crew. As a result, the contractor can clean more sewers per day than the municipality can with its own forces. He can get through blockages that otherwise could be eliminated only by digging up and replacing the pipe. Equipment depreciation, rod breakage, and the possibilities of tile damage become the responsibility of the contractor. Another important item to consider is the fact that, by using the services of a contractor, the regular maintenance crew is free to handle service calls and routine duties. Because of all these factors, the cost of using an outside contractor for an over-all sewer cleaning program is seldom higher, and many times lower, than doing the job with departmental forces.

Table 2

Acceptable Limits for Infiltration in Sewers

Pipe Size	gal/mile of sewer/ 24 hrs
6 in.	4,000
8 in.	5,000
10 in.	6,300
12 in.	7,500
15 in.	9,500
18-36 in.	15,000

Infiltration

Excessive flows in any manhole usually indicate an infiltration problem which can be caused by any one of several things: poor pipe joints, defective manholes, diversion of surface drainage or underground water courses into sewers, improperly sealed plugs on the ends of laterals or Y-branches, discharge of roof and cellar drains into the sanitary system.

Infiltration will occur even with the best laid pipe. The maintenance department's problem is to keep it from becoming excessive. Table 2 gives a set of limits that have been specified by some designing engineers, which may help to determine when the danger point is reached. Infiltration can be measured easily with a 90-degree V-notch weir and a diaphragm recorder.

Besides examining the flow, the inspector should also check the physical condition of each manhole. Excessive amounts of sand, dirt, or grit in the invert may mean fissures in the manhole walls and/or openings between the manhole bottom and the sewer pipe. Manhole rungs should be sound, and the cover should seat tightly in the frame; loose covers are a frequent source of infiltration. If roaches are present in the manhole in quantity, it is a good indication that all of the sewer pipe in the area are infested with these pests. Chlordane is one of the chemicals which has proven effective in eliminating the roach problem.

Besides inspecting manholes, all storm water overflow and diversion devices should be checked. This work should be performed at least once a month, and also after every large rain storm. Catch basins should be cleaned at the same time.

A key item in any sewer system preventive maintenance program is inspection of all service connections prior to back-filling. By making sure that the connection between the service pipe and the main is as water and root proof as possible, an inspector can eliminate a common source of infiltration root blockage, and structural failure.

Maps and Records

Records should be kept of all sewer inspections. A master map of the system is essential. This map should show all the streets served and all pipe sizes. Large scale sectional maps are also needed, picturing the exact location of manholes, length of sewers, their grade and direction of flow. In addition, sectional maps should show the size, depth, and construction material of each sewer, location of T's and Y's, and the position of other utility pipes.

Some problems peculiar to certain areas, or having other sources as their cause are bound to arise. But careful attention to some of the factors discussed here will eliminate much aggravation and expense.

AWWA Warns On Tank Repair

Tank traps are being set again for unwary owners of elevated steel water storage tanks. Within recent months one community in California and another in Kentucky entered into tank painting agreements which permitted the contractor to inspect and make "necessary" repairs before painting. In California a suit resulted; in Kentucky the community was able to avoid a repair bill more than six times the amount of the painting contract by calling in an independent inspector and, then, was lucky enough to find a new painter in a hurry when the original painting crew walked off the job. But both the cost of the suit and the risk of prolonged loss of storage could have been avoided by such precautions as preinspection and separation of the painting and repair contracts.

It was to help water works men protect themselves in the handling of these and other details of painting contracts that AWWA more than 10 years ago worked out standards for inspecting, repairing, painting, and repainting steel tanks, standpipes, reservoirs, and elevated tanks, for water storage (AWWA D101 & D102, combined, 50 cents). Those standards have already saved tank owners millions of rivets, dollars, and headaches. If your tank needs paint, they're worth getting before letting.

Municipal demand for additional water supplies solved with . . .

Diatomite Filters

By WILLIAM GERMAN, Palmyra
Water Dept., Palmyra, N. Y.

■ DIATOMITE FILTERS replaced slow sand filters at Palmyra, N. Y. to meet the increased demand for water. Palmyra is in Wayne County on Route 31 East of Rochester, N. Y.

The village has obtained its water supply from Lake Canadaiqua since 1936. Water from this source is of better quality than that of Lake Ontario which could also have been tapped if necessary. A decided advantage in using Lake Canadaiqua water comes from its 197 ft elevation above the village. There are no pumping costs involved in transporting water from its source.

Prechlorination and slow sand filtration served the village needs for many years. But normal population growth and the ever increasing per capita consumption overburdened the modest treatment facilities. The problem was in selecting the type of plant best suited to replace the then existing facilities.

Diatomite pressure filters, were selected. The filters are the horizontal type illustrated in Fig. 1. The bolted end plate can be swung from a davit providing easy access into the unit. Each filter can be taken out of service, disassembled for inspection or cleaning and placed back on the line within a few hours.

Filter septums are stainless steel discs covered with orlon cloth. The discs are clamped together and skewed on the effluent tube which runs through the center of the filter. Each filter contains eighteen of these 18 inch diameter discs providing a total of 400 sq ft filtering area per filter.

The plant consists of a concrete block structure 26 by 38 ft. This building has a separate chlorination room and another for the diatomaceous earth slurry tank. The dust nuisance created when adding dry filter aid to the 300 gal tank is isolated to one area. Both J. M. Hyflo Supercel and Dicalite are used.

Raw water is forced under pressure through the filter into the clear well. Prechlorination has been abandoned since construction of the new plant. Post chlorination is practiced by injection on the effluent side of the filters. Prefluoridation has been practiced successfully since 1958, however, using hydrofluosilicic acid. Fluorine is added on the influent side of the filters by a small pump drawing from a drum of acid.

Operating costs for the diatomaceous earth alone average between $7.00 and $15.00 per mil gal of treated water. The turbidity of the raw water is normally 5 mg/L except after heavy rains or unusually high winds. Only on one occasion have filter runs been as short as 1.5 hours. Generally filters are backwashed at least once a week.

The choice of diatomite filters coupled with the excellent quality of raw water, plus negligible pumping costs, has provided the village additional supplies of water to meet demands. An outmoded treatment facility was replaced at low capital investment.

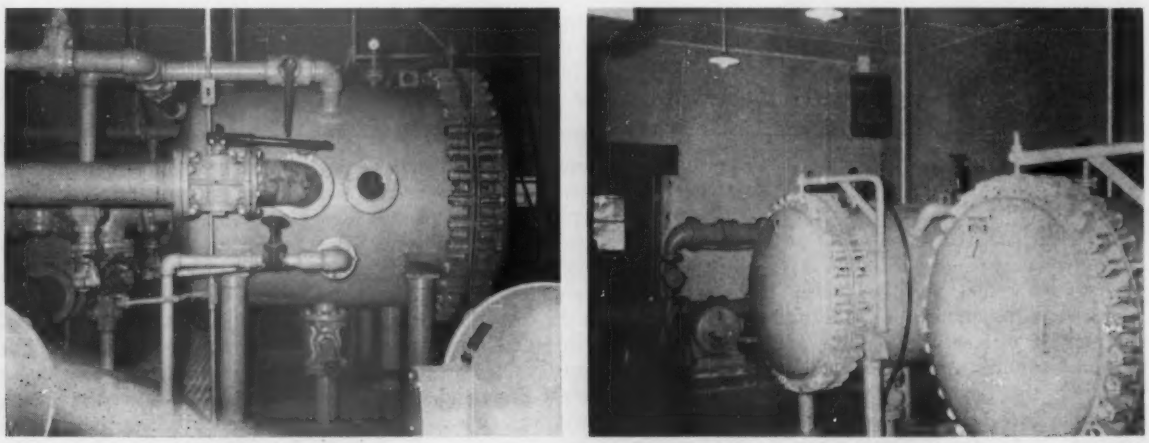


FIG. 1 FILTER INSTALLATION—Horizontal, end-bolted filters were selected for easy access.

The effluent of the Nine Spring Sewage Treatments Works shown here now flow through an . . .

Outfall Around the Madison Lakes

by JAMES G. WOODBURN, Pres.
Madison Metropolitan Sewerage Commission
Madison, Wisc.

EDITOR'S NOTE: Among the more frequently studied bodies of water in this country are Lake Waubesa and Lake Kegonsa, the lower two of the four so called Madison lakes. The work of Sawyer and others on the fertilizing effect on the algae of these lakes of the nitrogen and phosphorus in the effluent of the Madison plant have been reported in the literature over the years. The construction of an outfall force main and open channel to upper Badfish Creek will now introduce the Madison effluent into the Yahara river below the two lakes as well as most of the dams on the river thus eliminating the problem. Mr. Woodburn in this article describes the construction of this $3 million project.

■ SEVERAL DECADES of discussion, engineering studies, political agitation, public hearings, legislation and court decisions culminated in December, 1958, when the Madison, Wisconsin, Metropolitan Sewerage District began pumping effluent from its Nine Springs Sewage Treatment Works through a pipeline to a channel which bypasses the two lower lakes of the chain of four generally known as the Madison Lakes.

This $3 million project was built pursuant to legislation requiring the District to cease introducing effluent into the lakes unless further treatment were applied to remove the nitrogen and phosphorus which stimulate the growth of algae and other aquatic plants in lakes. No practicable method being known for such removal, the effect of the legislation was to require bypassing the lakes.

The Nine Springs Works provide primary and secondary treatment for all wastes from the metropolitan area of 85 square miles and a population of 135,000. The flow through the works averages about 18 mgd, with occasional peaks of over 30 mgd. Primary treatment consists of screening, grit collection and sedimentation. In the secondary stage, about 5 mgd are treated by the trickling filter pro-

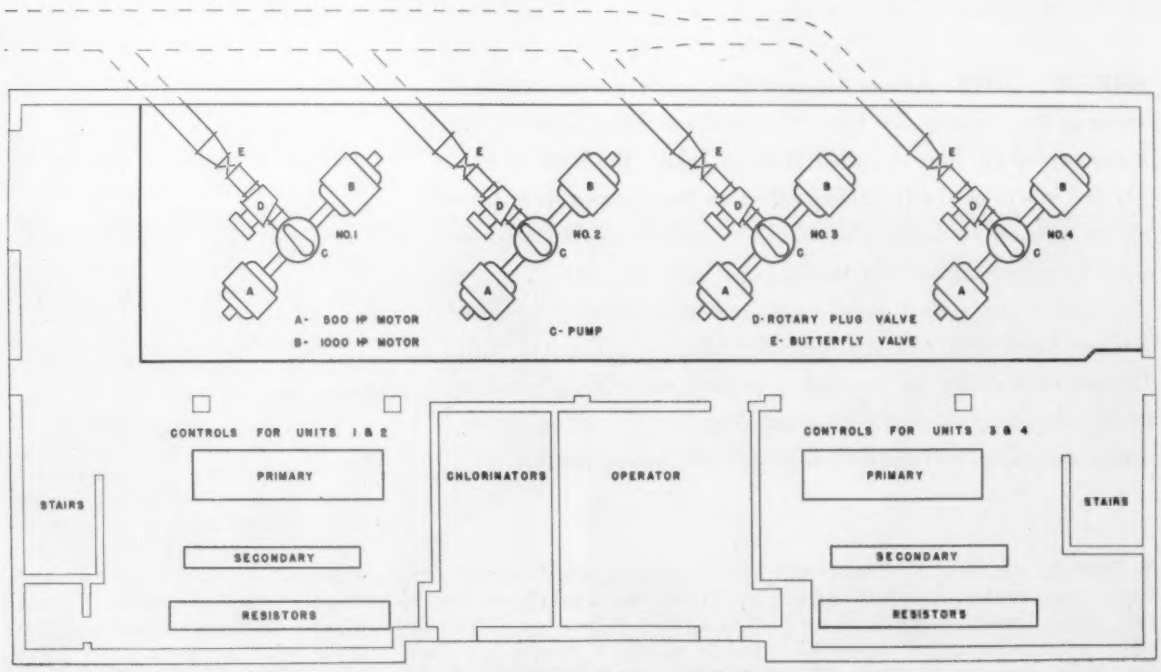
NEW OUTFALL ROUTE via Badfish Creek bypasses Lakes Waubesa and Kegonsa.

cess and the remainder by the activated sludge process. The effluent leaving the final settling tanks generally shows a content of both B.O.D. and suspended solids of between 20 and 25 ppm.

The Problem

Since the opening of the Nine Springs Works in 1928, the effluent has been discharged into the Yahara River about a mile above Lake Waubesa. Four miles below that lake the river enters Lake Kegonsa, from which it flows through the city of Stoughton to the Rock River. In the 19-mile stretch below Kegonsa are four dams which pond water for hydroelectric power plants.

Following the decision by the State Supreme Court holding the legislation valid, the District retained as engineering consultant the firms of Mead and Hunt, Inc., Madison, and Greeley and Hansen, Chicago, to study possible routes for discharge of effluent. From the 14 routes reported on, the District Commissioners selected the "Badfish Creek route" as the best. Although this route involved pumping the effluent over a divide 80 feet higher than the works, the annual cost was found to compare favorably with the least expensive all-gravity route. Weighing heavily in the decision was the fear that introducing the effluent into the Yahara River just below the outlet of Lake Kegonsa, which would have conformed with the statute, might cause the District to be held responsible for any algae troubles that might occur in the series of ponds in the river below that point. The Badfish



DIAGONAL ARRANGEMENT of units in pumping station is economical of space.

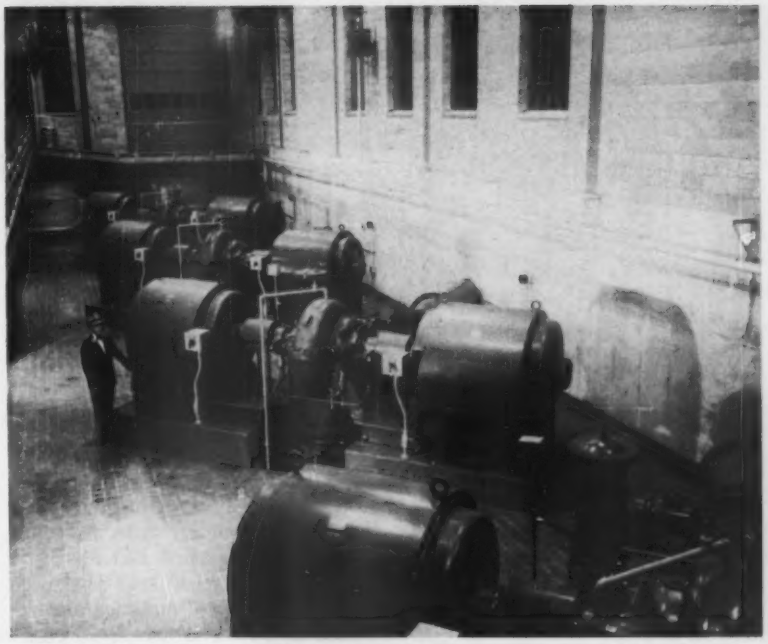
Creek, on the other hand, has an average of slope of over 6 feet per mile and the resulting velocity of flow is expected to inhibit the growth of algae.

The project as constructed includes (1) a pumping plant with an installed capacity of 144 mgd; (2) 5.1 miles of 54-inch concrete pipeline; (3) 3.8 miles of new open channel; and (4) improvement of 10.3 miles of existing channel. Twelve different contracts were let for the work on a combination of lumpsum and unit-price bids. The firm Mead and Hunt, Inc., designed all parts of the project and supervised construction.

Design Features

The facilities provided for the discharge of effluent are considered adequate to handle the expected increase in flow to the year 1990, or a discharge of over three times the present average rate.

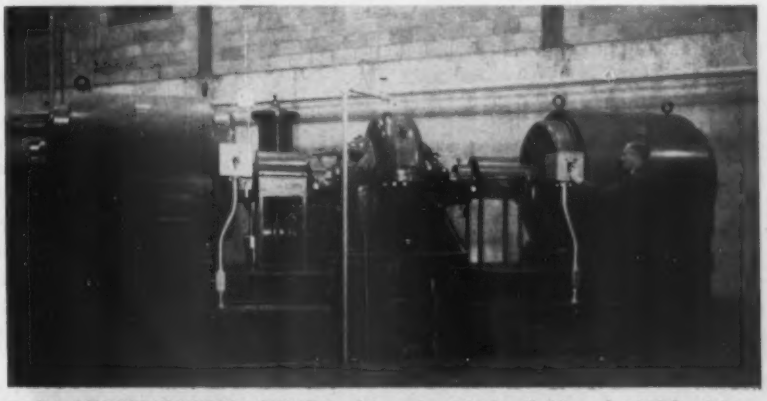
Pumping station. The pumps are located in a new building 121 by 57 feet in plan, and are low enough in elevation to receive effluent under positive head from two new equalizing basins, each 130 feet in diameter. There are four 24-inch single-stage double-volute centrifugal pumps, each with a rated capacity of 25,000 gpm at 110 feet head. Each pump can be driven by either a 500-hp, 700-rpm motor on one end or a 1000-hp, 880-rpm motor on the other. The present average flow can be handled by one pump but two will be needed for peaks. The excess pumping capacity was considered advisable on the theory that if one pump were out of service for repairs or other reason, one would still be available as a spare for additional emergencies. On the discharge side of each pump are an automatic hydraulically-operated cone valve and a manually-operated butterfly value. It requires about four minutes for the cone valve to close after the switch is thrown to cease pumping. During this time the motor and pump continue to operate to prevent backflow. One of the tests made on each motor prior to commencement of regular pumping was to suddenly cut off the power to the motor and determine the maximum reverse speed produced by water from the pipeline flowing backward through the pump while the cone valve is closing. The motors are expected to withstand a 50 percent overspeed, but at no time during the tests did the overspeed exceed 10 percent.



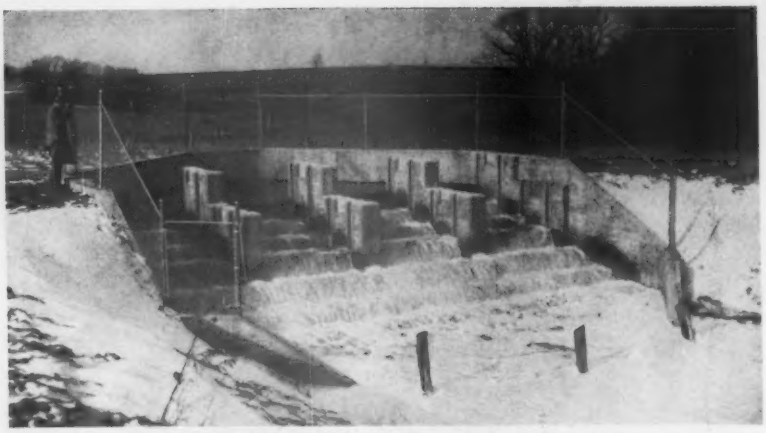
INTERIOR OF NEW PUMPING station.

Adequate chlorination of the effluent was required by the State Board of Health as a prerequisite to the use of the Badfish Creek route. The creek is a fishing and recreational stream and is also, in its lower reaches, open to dairy cattle. Chlorination was therefore considered a necessary safeguard from the health standpoint. The switchboards, chlorination equipment and operator's office are located on the first balcony of the pumping station. On the second balcony are the chemistry and bacteriology laboratories for the treatment works and the offices of the works superintendent.

Pipeline. The pumps discharge into a header leading to the 54-in. pipeline, which consists of 27,000 feet of 100-psi reinforced concrete pipe. The line passes over six summits, at each of which is an air release manhole. In the manholes are a total of 13 6-in. controlled-closing air valves. In addition there are nine blow-off manholes and 10 access manholes. The discharge end of the pipe is 85 feet higher than the pumps. During tests of the pipeline the pressure graphs showed only minor rises due to water hammer when pumping was started or stopped. The air valves functioned properly in opening to admit air and prevent a vacuum in the pipe when pumping was stopped, but it was found that their slow



24-IN. WORTHINGTON PUMP is driven by 500-hp (left) and 1000-hp Marathon motors.



STEP AERATOR AT DISCHARGE end of 54-in. pipe

action in closing when pumping was resumed permitted enough water to escape to erode the drainage ditches down which it flowed. Riprapping or paving the ditches thus became necessary.

New channel. The outfall end of the pipeline is connected to the Badfish Creek by 20,200 feet of new ditch having a bottom width of 16 ft and sideslopes of 1½ to 1 except in rock cuts where the slopes are ¼ to 1. The grade of the channel is 2.6 feet per mile. For a discharge of 18 mgd, assuming n = 0.025, the depth of flow is expected to be 1.1 ft with a mean velocity of 1.5 fps. The channel winds through rolling country and some of the cuts are nearly 30 feet deep. At one point the channel is in fill across a ravine, with the surface runoff carried underneath. Three highway crossings required culverts. Preliminary plans had called for a longer pipeline and less open channel, but further studies showed that substitution of ditch for pipe resulted in a material saving in cost.

To restore oxygen to the effluent after its passage through the pipe, two aerators are provided in the new channel. One is located at the end of the pipe and the other is 3240 ft above the point of discharge into the Badfish Creek. The aerators are, repectively, 35.5 and 30 ft wide and cascade the water in seven and five steps with a total fall of 6.5 and 5.5 ft.

Channel Improvement

Years ago the Badfish Creek in Dane county was straightened and widened to serve as a drainage ditch. It also carries effluent from the sewage treatment works of the village of Oregon. Additional widening and deepening were necessary in order to meet the design requirement that the water level with Madison effluent added be no higher than formerly in order to avoid raising the ground water level in adjacent farm lands. The creek was improved from the end of the new outfall channel to the Dane-Rock county line, a distance of 54,500 ft. For the first 22,200 ft the bottom width was made 16 ft and for the remainder of the distance 20 ft. The average channel grade in these sections is respectively 4.75 and 8.05 feet per mile. One new highway bridge was required and protection was provided for four other bridges. Four new farm bridges were constructed with timber piling and concrete deck.

In 1955, at the request of the District, the U. S. Geological Survey established a stream gaging station on this section of the Badfish Creek with part of the cost borne by the District. In the 2½ years for which records are now available, the flow has averaged 9.6 cfs, with a maximum day's reading of 96 cfs and a minimum of 5.3 cfs. From the Dane-Rock County line to its junction with the Yahara River, the Badfish has a considerably larger natural flow and the channel capacity is sufficient to handle the added effluent without serious increase in depth. Therefore no work was done on that part of the channel.

• Water supplies for New York City are checked weekly at 165 sampling points throughout the city.

• In the study of plastic pipe for potable water supplies it was found that waters exposed to plastic pipes were not found to have any greater intensity of odor, as indicated by threshold number, than did the controls.

• Laboratory scale treatment at the Lawrence Experiment Station of a combined tannery waste by activated sludge indicated that better than 95 per cent BOD removals could be obtained with loadings up to 100 lbs. per 1000 cubic feet aeration capacity per day and with 170 lb. loading, 90 per cent could be removed.

A Point to Ponder

Within the past few months the U.S. Census Bureau has released its predictions for both liberal and conservative estimates of future populations, as follows:

	Population Estimate—Millions	
Year	Liberal	Conservative
1960	181.2	179.4
1965	199.0	191.5
1970	219.5	202.5
1975	243.9	215.8
1980	272.6	230.8

Think of it—in just 22 years there will be anywhere from 55 million to 97 million more persons in this country than there are now. Not only will there be more people but all of them will be using more water (and discharging more sewage) than does our present population.

Are you gearing your future planning to this population boom?

Finding and eliminating sources of flammable gases in the sewer system, providing sewer operational information, and maintainance of records is the responsibility of the unit charged with

Explosive Gas Detection, *in San Francisco*

by A. E. BAGOT and E. J. MURPHY, Chemist and Water Chemist respectively for the City and County of San Francisco, Calif.

■ ACCUMULATIONS OF GAS OCCURRING within municipal sewers are hazardous to both public and property. Flammable gas originates from ruptured gas mains, industrial discharges, and from the anerobic breakdown of organic sewage solids. In November 1951, San Francisco formed a gas detection unit to minimize and control this danger. The new unit was given the following assignments:

1. Find and eliminate dangerous accumulations of explosive gas, other hazardous gases and oxygen deficiency within the sewer system.
2. Provide the Bureau of Sewer Repair and Sewage Treatment with additional operational information regarding conditions within the sewer system.
3. Determine the cause of any explosions and gather data for the protection of the city in the event of legal action.

Unit Organization

The gas detection crew is under direction of the Bureau of Sewer Repair and Sewage Treatment of the Department of Public Works. The unit consists of a mobile laboratory and two men. A chemist is responsible for all sampling, analysis and inspections. Chemical training and experience is considered essential to insure the validity of data collected and to provide an expert witness in court actions involving the City regarding effects caused by gases. He is assisted by a laborer.

The laboratory itself consists of a ½ ton Dodge Route Van furnished with the following instruments and equipment.

1. Mine Safety Appliance (MSA) Explosimeter Model 2.
2. Mine Safety Appliance (MSA) Koehler Flame Safety Lamp.
3. Mine Safety Appliance (MSA) Hydrogen Sulfide Detector.
4. Mine Safety Appliance (MSA) Colorometric Carbon Monoxide Tester.
5. Mine Safety Appliance (MSA) Carbon Monoxide Indicator Type 1941.
6. Fisher M-Scope Model 49A.
7. Scott Airpak Model 6000B4A (Self breathing equipment).
8. Laboratory Glassware.
9. Drafting Equipment.
10. Maps and Charts.
11. Safety Equipment (lights, warning flags, barricades, etc.,)

Complete records, charts and files of data collected by the unit are maintained within the offices of the Bureau of Sewer Repair and Sewage Treatment.

Unit Operations

The gas detection crew routinely surveys City sewers, investigating approximately 600 to 800 manholes per month. Sampling frequency in the various sections of the City is based on the hazard potential of each section.

The investigative procedure consists of chemically testing for gases within the manhole followed by visually inspecting the sewer itself for dirt, sludge deposits and structural defects.

Gases are chemically tested by as-

INTERIOR of route van showing test instruments and sampling tubes.

MAKING A TEST, the sampling tubes from the detection instruments are attached to ventilation holes in the manhole cover.

pirating them via a rubber tube from ventilation holes in the manhole cover to the various detection instruments. The manholes are checked for explosive contents, hydrogen sulfide, carbon monoxide, and oxygen deficiency. The findings are recorded on file cards. At the end of each day positive values are plotted on a large map of the City. Colored pins are used to represent the different gases for which tests are made.

Most vapors can be distinguished from each other by their characteristic odors. Therefore when indications of explosive gas within a manhole are found an effort is made to identify the gas by smelling the sample as it is pumped through the aspirator bulb.

Natural gas has a distinct odor but is usually masked by other odors within the sewer unless there is a large quantity of the gas present.

If the explosive gas in the manhole is a chemical vapor, all side sewer vents in the vicinty of the manhole are tested with the explosimeter to locate the establishment discharging the chemical into the sewer. This information is turned over to the City's Industrial Waste Engineer for a follow through and correction.

In situations where the explosive gas is not of a chemical nature and no odor of natural gas is present in the manhole, all water meter boxes on the sidewalk in the vicinty of the manhole are tested with the explosimeter. Gas from leaky mains seep through the ground and accumulates in water meter boxes as well as sewers. The meter box with the highest gas content usually indicates a gas leak near that area.

Manholes containing explosive vapors suspected to be coming from a gas leak are immediately reported to the Utility Company. The company sends one of its leak crews to make temporary repairs until a permanent repair can be made. Excellent cooperation is received in this regard. Usually the repairs are made the same day they are discovered since the elimination of leaks producing an explosion hazard is of top priority. After repairs have been completed the manhole is retested until the gas detection unit is satisfied that the condition has been permanently corrected.

All findings of sludge deposits and structural defects within the sewer systems are reported to the Bureau of Sewer Repair and Sewage Treatment for correction.

Results of The Testing Program

The gas crew has made more than two complete surveys of the City since its organization. Overall conditions within the sewer system have been charted and the more potentially dangerous areas have been isolated for the most frequent inspection. The number of manholes tested each year as well as those containing carbon monoxide, hydrogen sulfide, oxygen deficiency and explosive gases are shown in Table I.

None of the manholes tested for carbon monoxide showed over 0.005% concentration of the gas. Most of the affected manholes were found in the downtown area on those streets having a heavy flow of traffic, leading to the belief that carbon monoxide is probably due to automobile exhaust fumes entering the manhole through the ventilation holes in the cover.

San Francisco sewers are relatively free of sludge deposits due to their short runs and high flow velocities. Because of this, hydrogen sulfide produced by the anaerobic breakdown of organic matter, has only been detected ten times within the last six years.

Oxygen deficiencies are found in manholes containing large concentrations of other gases. In these cases the oxygen deficiency is caused by a simple displacement of the oxygen by the foreign gas.

It is interesting to note that in over 95 percent of the manholes containing explosive gas, based on the lower 5 percent explosive limit of methane gas, it was found that the condition was due to a natural gas leak. Explosive gas in other manholes was traced to deleterious chemicals discharged into the sewer system.

Based on these results it can be safely stated that explosive gas is not likely to be caused by digestion of sludge in a sewer within the City of San Francisco.

Acknowledgment

Appreciation is expressed to Sherman P. Duckel, Director of Public Works, L. J. Archer, Assistant Director of Public Works, for their active interest in the operating details of the gas detection unit. We are also grateful to Ben Benas, Superintendent of the Bureau of Sewer Repair and Sewage Treatment for his constructive criticism of the manuscript.

Table I

Explosive Gas Survey Unit Summary Of Test Data

ITEM	1951* 1952	1952 1953	1953 1954	1954 1955	1955 1956	1956 1957	1957 1958
Total Manholes Tested	2975	7154	7236	5884	7871	7270	9737
Total Manholes Containing Hydrogen Sulfide Gas	0	1	0	8	0	0	1
Total Manholes Containing Oxygen Deficiency	6	14	6	0	6	9	6
Total Manholes Containing Carbon Monoxide Gas	14	79	4	79	2	4	6
Total Manholes Containing** Over 20% Explosive Gas	27	120	78	20	71	60	103
Total Manholes Containing** 3 to 20% Explosive Gas	172	799	402	174	384	145	284

* 6 months
** Based on the lower explosive limit of methane gas

Limitations on the available land required a

Compact Sewage Treatment Plant

by WILLIAM C. TRAQUAIR, Engineer
Fay Spofford & Thorndike, Inc.
Boston, Massachusetts

EDITORS NOTE: A problem encountered in Consulting Engineering and Health Department work is the sewage treatment plant which must be rebuilt in an area where space is at a premium. Such a problem existed at the Kent County Memorial Hospital where a high ground water table and a tight subsoil prevented efficient operation of the existing subsurface disposal system. Sufficient land was not available to expand the subsurface system so that loading could match soil and water table conditions. To correct this problem a compact activated sludge system was designed which is providing sufficient BOD removal to permit discharge of the effluent into a nearby creek.

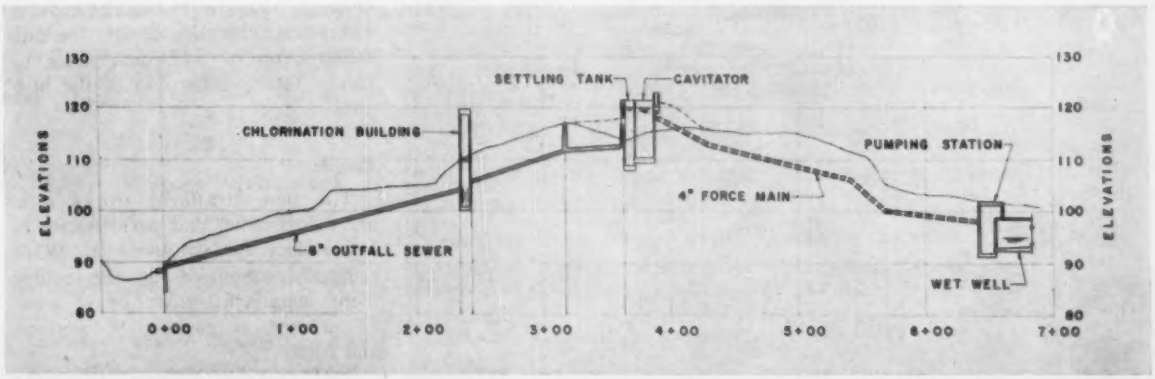
■ AN ANALYSIS OF costs and the application of accepted engineering methods usually are the two principal factors needed to carry a sewerage system rehabilitation project to a satisfactory conclusion. At Kent County Memorial Hospital in Warwick, R. I., another element entered into the design, land area, and the success of the system depended upon the design of a compact plant.

The need for improvements to the existing sewage disposal system at the Kent County Memorial Hospital was a well-known fact. Odors originating from a nearby brook and the results of tests conducted under the auspices of the Department of Health of the State of Rhode Island indicated inadequacies in the existing sewage treatment works, which consisted of a large septic tank, 14 cesspools and a leaching field. Preliminary investigations showed that two conditions, a high ground water table and a relatively impervious subsoil, were rendering the cesspools and leaching field ineffective. Combined, they were allowing sewage to enter a nearby brook almost untreated. Even in periods of normal rainfall, the flow in the brook was not sufficient to provide effective dilution for the effluent. During dry seasons, the condition became worse. In order to alleviate the situation, the author's firm was engaged to design rectifying measures.

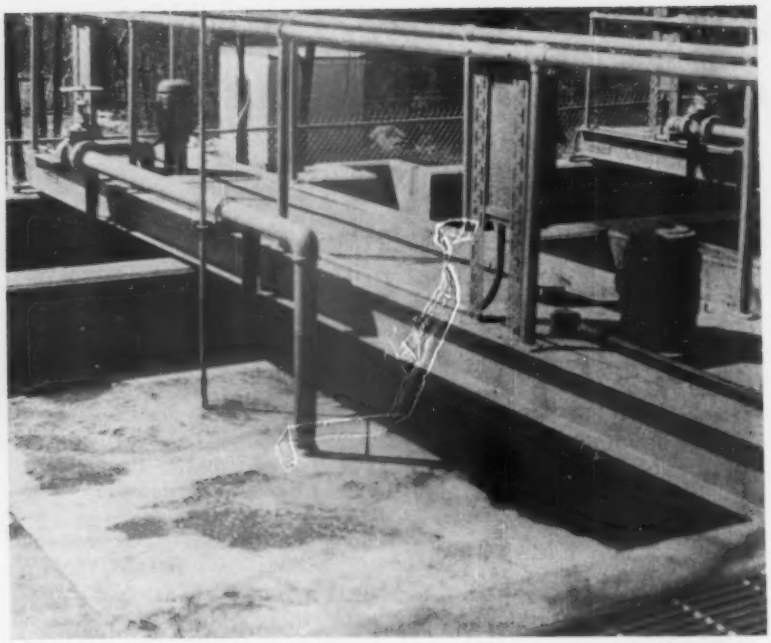
The Solution

To a sanitary engineer, such problems are not uncommon, and means to overcome them are relatively standard; either enlarge the existing leaching field and add more cesspools; or, install intermittent sand filter beds with underdrains. However, at Kent County Memorial Hospital, lack of sufficient land eliminated all possibilities of adopting these methods.

Re-examining the conditions under



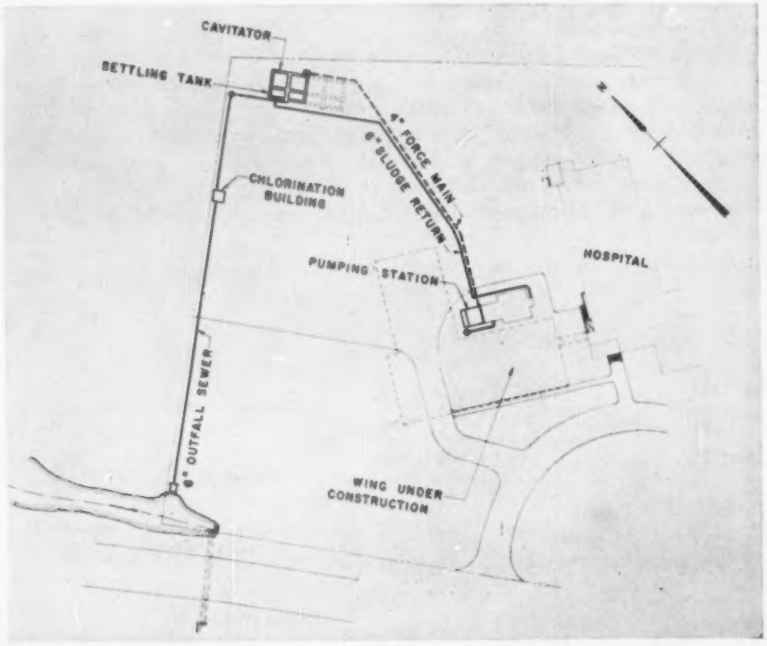
HYDRAULIC PROFILE of new plant.



AERATION and secondary settling tank in operation.

this limitation, the engineers, in cooperation with State Public Health and Hospital authorities, worked out a plan to utilize activated sludge with cavitator aeration tanks. This type of system has three advantages: (1) reasonable initial construction cost, (2) minimum land requirements, and (3) a high degree of BOD removal.

The new plan utilizes as much of the existing facility as possible, the tile field and the cesspools now receive the wastes originating in the basement which previously were localized in specific units and the 31,500 gallon septic tank is altered to function in a different manner. New equipment includes pumps to transfer effluent from the septic tank, force mains, the Cavitator units and settling basins, chlorinators, and an outfall sewer.



PLAN VIEW showing location of plant units.

The present function of the septic tank is that of a primary settling tank. The old siphon chamber is converted to a wet well for the new pumping station. At the end of this, an underground structure is built to house two vertical centrifugal pumps, installed to pump the effluent of the septic tank from the wet well, through a 4-inch diameter transite pipe to the Cavitators. An 8-inch by-pass was connected to the pumping station wet well to allow the sewage to overflow into the old cesspool field if power fails or the pumps are out of service for any reason. Access to the pumping station is by means of a stairwell. The pumps are automatically controlled by floats and float switches.

The sewage from the pumping station is discharged first into a distribution box, and thence into the aeration tanks. After aeration the sewage is settled and the sludge returned to the aeration tank. The settling tank effluent is chlorinated and discharged through a 6-inch outfall sewer to the adjacent brook. A reinforced concrete and cement block building houses the equipment for chlorinating the effluent before it is discharged by gravity into the brook 250 feet away.

Several precautionary measures give the hospital added assurance of troublefree operation. If, for any reason, sludge builds up in the secondary settling tanks, it can be diverted to the septic tank through a 6-inch cast-iron sludge return line paralleling the force main from the pumping station. Space is provided adjacent to the treatment units for the installation of a polishing filter in the event that further treatment is deemed necessary. Also, provisions have been incorporated in the design for the construction of additional units to handle future expansion of the hospital.

Results

The new treatment works now are in operation and performance is better than initially predicted. BOD removal guaranteed by the equipment manufacturer—to be at least 75 percent, is running 90 percent and better.

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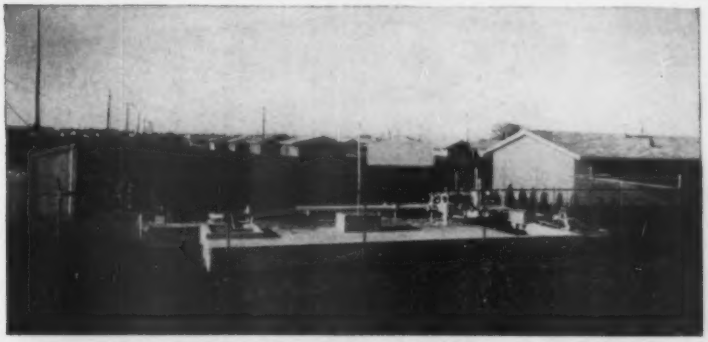

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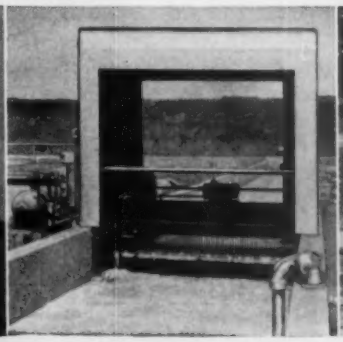

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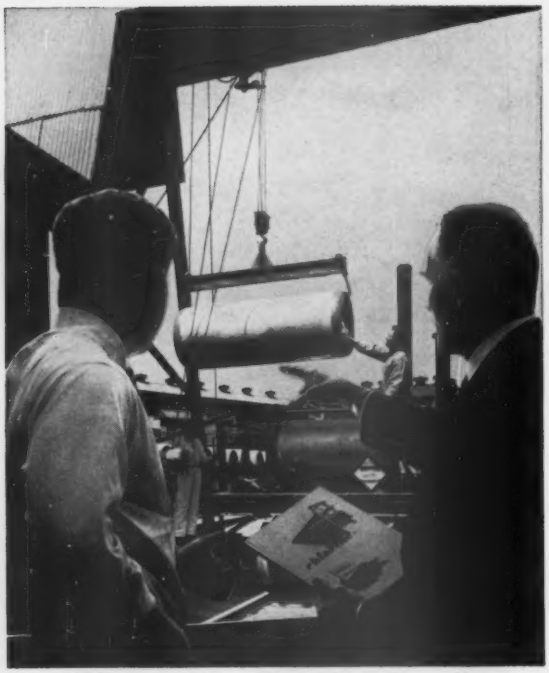

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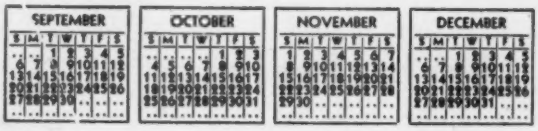


Nov. 4-6—Roanoke, Va. *(Hotel Roanoke)*
VIRGINIA SECTION, A.W.W.A., Secy., E. H. Ruehl, R. Stuart Royer & Assocs., 15 W. Cary St., Richmond, Va.

Nov. 5-6—Sidney, Nebr. *(Sidney Motor Hotel)*
NEBRASKA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., V. J. Lechtenberg, 2549 Farnam St., Omaha 31, Nebr.

Nov. 9-11—Durham, N. C. *(Washington Duke Hotel)*
NORTH CAROLINA SECTION, A.W.W.A., Secy., D. Y. Brannock, Supt., Water & Sewage Plants, Burlington, N. C.

Nov. 10-13—Atlantic City, N. J. *(Chalfonte Hotel)*
PENNSYLVANIA WATER WORKS ASSN., Secy., Harry A. DeWire, 29 Chestnut Street, Lewistown, Pa.

Nov. 15-19—Tampa, Fla. *(Hillsboro Hotel)*
FLORIDA SECTION, A.W.W.A., Secy., J. G. Simmons, Plant Supt., West Palm Beach Water Dept., Box 1311, West Palm Beach, Fla.

(Jointly With)

FLA. SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Ralph H. Baker, Jr., State Bd. of Health, P. O. Box 210, Jacksonville 1, Fla.

Nov. 16-20—Stillwater, Okla. *(Okla. State University)*
OKLA. WATER, SEWAGE & INDUSTRIAL WASTES ASSN. 33RD ANNUAL MEETING, Secy., H. M. Crane, Okla. State Dept. of Health, 3400 North Eastern, Oklahoma City, Okla.

Nov. 18-19—Indianapolis, Ind. *(Washington Hotel)*
INDIANA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Frank D. Wraight, Dept. of Health, 1330 W. Michigan St., Indianapolis 7, Ind.

Nov. 19—Boston, Mass.
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

Dec. 6-9—San Francisco, Calif. *(Sheraton Palace)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Secy., F. J. Van Antwerpen, 25 W. 45th St., New York 36, N. Y.

Dec. 10—Freeport, Maine
MAINE WATER UTILITIES ASSN., Secy., G. F. Laurin, 89 Western Ave., Augusta, Maine

TRAIL of service that never sleeps

Products for industry: electrical generation, distribution and utilization equipment; pumps; compressors; mechanical power transmission equipment; processing machinery; motors and control; water conditioning systems, plus materials handling equipment.

Backing up the broad line of Allis-Chalmers products are more than 200 field installation and service men. Available day or night, they respond promptly to the emergency needs of A-C customers.

Hundreds of other facilities, strategically located, guarantee lifetime service support to Allis-Chalmers products wherever they are applied.

Regional Offices are located in key industrial cities.

District Offices across the country cover every city or area wherever Allis-Chalmers equipment is used.

Certified Service Shops are only minutes away for expert round-the-clock service.

Warehouse Stocks are within easy reach of all these service teams for fast delivery.

Ask your A-C representative about this coast-to-coast service organization, and the lifetime service support behind every A-C product, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-1198-GI

Equipment News

CONTINUED FROM PAGE 28A

hazards of body and clothing injury. It also eliminates the need for using special cleaning devices such as rodding and mechanical rats.

Supplied as a liquid concentrate, F. O. -287 is a viscous, water-soluble mixture of surface active agents, a heavy duty detergent and a corrosion inhibitor. Either hot or cold water may be used for dilution.

The extent of grease buildup and the water temperature determine the optimum concentration and length of time the F. O. -287 solution is left in the line. Exceptionally heavy deposits of grease can be removed by overnight exposure. After initial cleaning, Fine Organics recommends that lines be treated once a month only with a solution of five ounces of cleaner per gallon of water.

Radiation Monitoring Unit

1110

Victoreen Instruments Co., Cleveland, Ohio has developed a super-sensitive new monitoring system especially designed to keep constant check on traces of radioactivity in water supply systems.

The new Victoreen equipment is connected into the water supply at one or more key points, so that its crystal detector, sensitive to both beta and gamma rays, is exposed to the flow at all times. The detector is housed in a heavy stainless steel-lined three-inch lead shield, to exclude normal atmospheric radiation.

Water flows through the housing continuously. Trace amounts of radio-activity general a signal which is amplified by a device designed at Oak Ridge Laboratory. This device controls the marking-pen on the chart. The equipment incorporates an analyzer which makes it possible to identify a particular contaminant in the flow.

Use of the equipment, according to the company, records the small, harmless radiation always present in any water supply or sewage system, and immediately registers any significant increase caused by fallout, rain or leakage from hospital and other scientific or industrial equipment, providing a complete safety and control system.

The equipment automatically checks itself every two hours. A tiny particle of strontium 90 is edged into place near the detector at this interval, and will produce a reaction of known quantity if the device is registering accurately. Absence of this bulge on the strip chart recording at two hour intervals would immediately indicate a failure or malfunction, and set off a bell or other aural alarm as well.

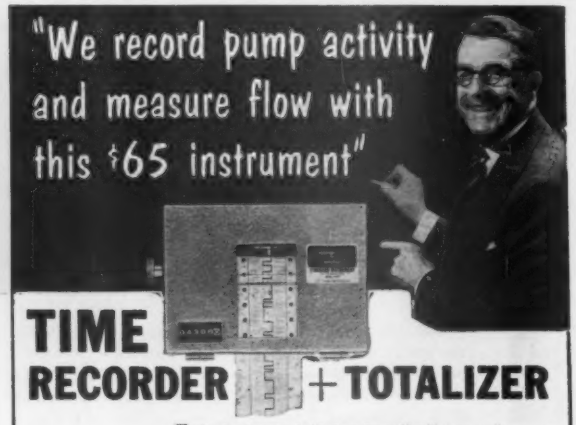
Rubber Seat Butterfly Valve

1111

Henry Pratt Company, Chicago, Illinois has developed a new Rubber Seat Butterfly Valve.

The Monoflange Mark II Butterfly Valve will feature numerous technical innovations and is being offered for 150 psi tight shutoff in sizes 4"-20". A wide range of material trim and valve actuators for manual or automatic operation are available.

"We record pump activity and measure flow with this $65 instrument"



TIME RECORDER + TOTALIZER

what T-R-T is — An instrument that automatically records on a strip chart the "on-off" time of any pump (or machine) to which it is electrically connected. Strip chart is chronologically-printed, runs up to four months without change.

what T-R-T does — Marks on chart when pump starts, how long it runs, when it stops. Elapsed time meter totals operating time. Operations counter (optional at additional cost) records number of pump starts.

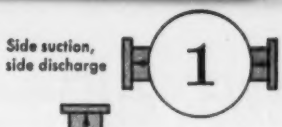
how T-R-T is used — To measure flow, simply multiply rated capacity of pump per hour by hours of pump operating time. Strip chart furnishes a single-source basis for cost analysis, flow pattern, and pump maintenance. Many other applications. For full details, write for Brochure WR-1.

standard INSTRUMENT CORPORATION
657 BROADWAY, NEW YORK 12, N. Y.

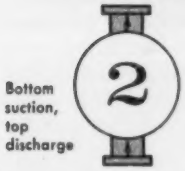
automatic engine controls

full automatic controls
d.c. solenoids
relays and contactors
speed sensitive switches (1, 2 & 3 element)
special control panels
liquid temperature switches
oil pressure switches
safety alarm panels

SYNCHRO-START PRODUCTS, INC.
Since 1932
8151 NORTH RIDGEWAY AVENUE, SKOKIE, ILLINOIS



Pinched for pump space?



Let the world's broadest centrifugal pump line lead you out of your installation space squeeze. Here's versatility that blankets every suction or discharge requirement — with horizontal (see 1 to 4 illustrated) or vertical (see 5 and 6) mountings. Capacities run from a flow to a flood — to 250,000 gpm or more.

The size of the A-C pump line, the service and experience behind it, are without equal in industry. For data, contact your A-C representative or distributor. Or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

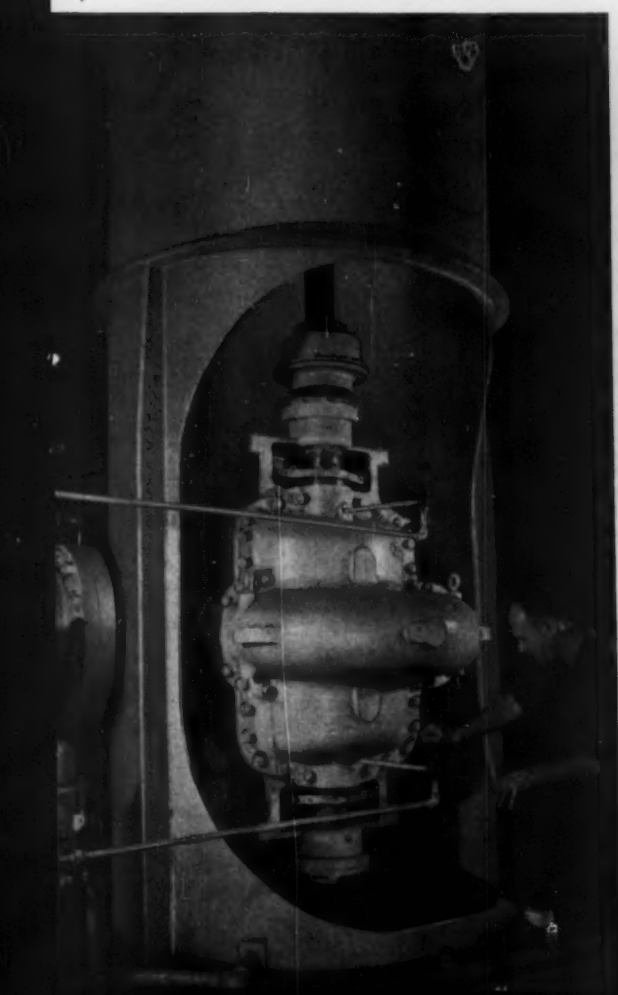
Make the most of it with an Allis-Chalmers centrifugal pump

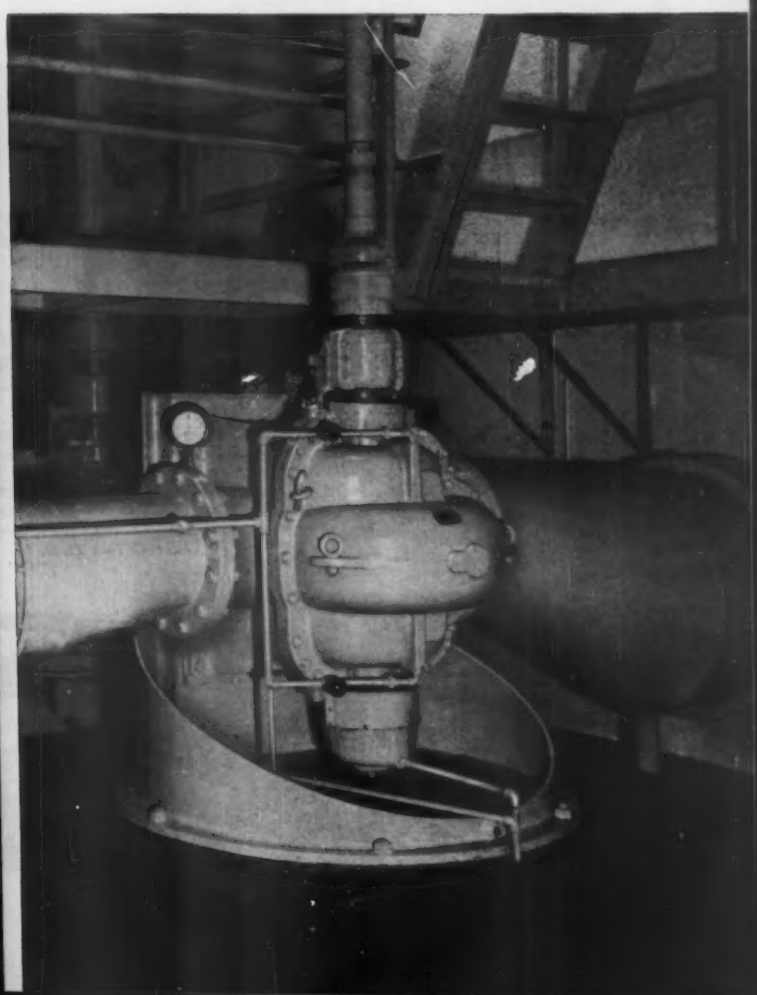
ALLIS-CHALMERS

A-1197-GI

Vertical mounting with barrel supporting motor provides for discharge at either 90° to the suction (shown at lower left) or at 180° to the suction.

Mounted vertically, Allis-Chalmers pumps can be driven with motor on another floor — discharge at either 180° to the suction (shown at lower right) or at 90° to the suction.





News of Suppliers

Hagan Acquires Bruner Corp.

Hagan Chemicals & Controls, Inc., Pittsburgh, Pa., has announced that Bruner Corporation, a leading manufacturer of water treating equipment with plants in Milwaukee and Los Angeles has become a wholly-owned subsidiary.

In announcing the acquisition, Hagan President W. W. Hopwood said the new subsidiary provides a "natural extension" of Hagan's interests in the water treatment field. Bruner manufactures a full line of water softeners for household, commercial and industrial use; filtration equipment for swimming pools, laundries and oil field water-flood plants; and sump pumps for homes and commercial applications.

T. W. Bruner, president of the Milwaukee firm since its founding in 1945, continues in that capacity. Bruner said no changes in personnel are anticipated and that Bruner will continue its policy of exclusive marketing through the plumbing trade and its established outlets.

ALGAE-FREE WATER
MEANS
Copper Sulfate
treated water
Not only is Triangle Brand Copper Sulfate successful in controlling algae but it also is effective in killing some aquatic weeds. Since the weeds are submerged and disintegrated, there is no chance of them floating down stream to start new infestations, or to clog the waterway.
In sewage systems, Triangle Brand Copper Sulfate prevents roots and fungus from clogging pipes. However, there is no danger of affecting the surface trees owing to the low concentration of copper sulfate necessary to be valuable.
The new booklets "The Use of Copper Sulfate in The Control of Microscopic Organisms" and "Copper Sulfate for Root and Fungus Control in Sanitary Sewers and Storm Drains" will keep you up to date. Send for a copy today! Phelps Dodge Refining Corp., 300 Park Ave., New York 22, N. Y.
PHELPS DODGE REFINING CORP.
NICHOLS
CHEMICALS

Horace Horton Dies CB&I Board Chairman

Horace B. Horton, board chairman of Chicago Bridge & Iron Company, died on September 17 in Chicago. He was 73 years of age.

Mr. Horton was active in the affairs of the company, founded by his father, and he has served as board chairman of the world-wide steel fabricating and construction firm since 1956.

The oldest employee in length of service with the company, Mr. Horton joined CB&I in 1907. Five years later he was elected treasurer and a director. He was named president in 1945 and chairman of the board 11 years later. In addition to his duties with CB&I, he was a director of several subsidiary companies.

Mr. Horton was a member of the National War Labor Board from its organization in 1942 until the end of World War II. He also served on the Hoover Commission in 1954-55.

He was graduated from the University of Chicago in 1906 with a B. S. degree and took graduate work in engineering at the University of Illinois the following year. In 1942 he was awarded the honorary degree of Doctor of Business Administration by Thiel College, Greenville, Pennsylvania.

Eimco Appoints Michigan Sales Reps

The Eimco Corp., Salt Lake City, Utah, has announced the appointment of Colley and Schlee, Inc., 24681 Telegraph Road, Southfield, Michigan as sales representatives for the company's line of water and sewage treatment equipment.

The Colley and Schlee organization, will handle sales of this equip-

CONTINUED ON PAGE 102A

CUTS SEWAGE TREATMENT COSTS UP TO 27%

Gilbert W. Clifford
Gilbert W. Clifford & Associates
Treasure Island, Florida
Designed around Hi-Cone® for the Carol City, Florida plant

F. M. Cahaly
Fay, Spofford & Thorndike
Boston, Massachusetts
Chose a Cavitator® plant for Kent County Hospital, Warwick, R. I.

Marion C. Welch,
Cons. Engr.
Lexington, Ky.
Specified Hi-Cone® for the Lansdowne Subdivision, Lexington, Kentucky

Richard A. Stevens, A.I.A.
Stevens & Bertin, Architects
Rochester, New York
Kingdom Plaza Shopping Center, Seneca Falls, N. Y.

Harold D. Briley (left) and Harry E. Wild (right)
Briley, Wild & Assoc.
Daytona Beach, Florida
Specified Hi-Cone® for Clearwater's Marina plant

- Lowest capital costs
- Shortest aeration period; lower power demand
- Tank walls and floor continuously scoured
- Lowest operating and upkeep costs
- No falling off in efficiency
- No diffusers, blowers, or air cleaners
- No diffuser cleaning
- No expensive blower housing

Call in your Yeomans representative to fill out details on the cost story, or request the performance reports offered at right.

YEOMANS

☐ Cavitator® Engineering Report: technical analysis and report covering cost and performance.

☐ The Hi-Cone® Studies: Dr. W. E. Howland's Study and Commentary on the Manchester Reports.

YEOMANS Brothers Company
1999-9 N. Ruby St., Melrose Park, Ill.

Please send me copies of the reports checked above:

Name_____

Title_____

Organization_____

Address_____

City_____ Zone_____ State_____

T-5923

News of Suppliers

CONTINUED FROM PAGE 100A

ment in Michigan, lower peninsula.

The appointment of Colley and Schlee, Inc. is part of a national sales expansion program to provide greater sales and engineering services to the multi-billion dollar market in this field.

Hodag Enlarges Facilities

Hodag Chemical Corporation, Chicago, Ill., has completed construction of its enlarged production, laboratory and office facilities.

The new facilities include stainless steel blending tanks and a sonic homogenizer for the manufacture of silicone antifoams and other silicone products.

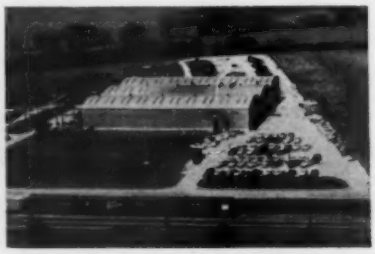
The construction has quadrupled Hodag's former plant space. Laboratory space has been tripled and office space doubled. Also, Hodag has added laboratory personnel and equipment as well as increased warehouse space for storage of raw materials and finished products.

Smith & Loveless Plant Expansion

Smith & Loveless, Inc., Lenexa, Kansas has announced the completion of an additional 12,000-square-foot production and assembly area.

This represents the third major expansion of the Smith & Loveless plant since it was opened in early 1958 and closely follows the construction of a 60 x 60-foot production bay which was just completed in April.

Most of the new 60 x 200-foot bay is being devoted to the manufacture of Smith & Loveless "Oxigest" sewage treatment plants and a new line of small pneumatic ejector sewage lift stations. The move substantially increases the production area for the larger sewage pump stations and pneumatic ejector stations fabricated in the plant.



It also provides space for an expanded maintenance department, water and sewage pump assembly, paint shops and another shot blast compartment in which the steel surfaces are blasted with steel grit to remove rust, slag and other foreign particles before applying the protective coating of epoxy resin.

Present plans call for further expansion of the factory area in 1960 with the addition of another large bay, providing more than three times the original factory floor space.

When it comes to your bucket jobs come to O'Brien *!*

See the all-power Sewerking® BUCKET MACHINE for 1960!

READY NOW—the revolutionary Bucket Cleaner that completely removes sand, big roots and other heavy sewer obstructions as never before! Built extra heavy, strong and safe—important automatic features for easy operation—greater power, pull and capacity to clean more sewer at lower cost!

ASK FOR INFORMATION ON THE NEW SEWERKING BUCKET DUMPER

WRITE, WIRE OR PHONE TODAY FOR FULL INFORMATION —without obligation!

AVAILABLE IN 9-16-25 HP.

NATIONWIDE SALES AND SERVICE
PHONE ROdney 3-7433

O'Brien **MANUFACTURING CORPORATION**
Dept. WS 1159 • 5632 Northwest Highway, Chicago 46, Illinois

A new office building, to be located in front of the manufacturing plant, is now in the final planning stage. Construction of this addition will begin this fall for occupancy in early 1960. The general and executive offices will be moved to the new building and the present in-plant office will be used as shop production offices, engineering production and research, and purchasing.

Chicago Pump Broadens Licensing of CRP

Chicago Pump Company, Chicago, Ill., has announced broadened licensing under its patents, of the use of the CRP Accelerated Sludge Digestion System, through the specification of consulting engineers with gas recirculation equipment supplied by approved and experienced manufacturers.

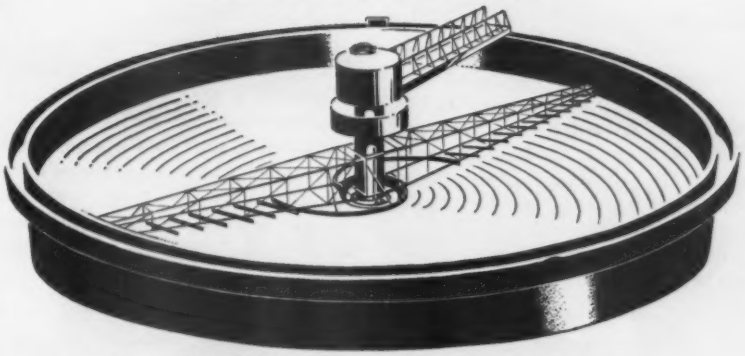
The CRP Accelerated Sludge Digestion System, under United States Patent numbers 2,777,815 and 2,786,025 incorporates gas recirculation in digestion tanks for high-rate digestion and is currently in operation or being installed in 43 installations. Eight of the plants are operating with digestion volume equivalent to from one-third to one-fifth past low-rate practice, or at approximately two-thirds cubic feet per capita.

Half of the plants incorporating the CRP Accelerated Sludge Digestion System utilize converted existing digesters for the System, and the remainder of the plants utilize new digestion tanks designed specifically for the CRP Accelerated Sludge Digestion System.

A total of nine of the plant installations have been in operation in excess of three years. In all installations utilizing existing tanks, conversion to CRP eliminated needed digester construction, even though the units required expansion of capacity on the basis of low-rate design and operation practice.

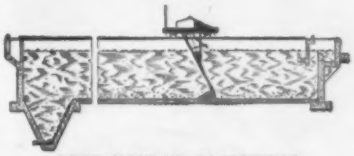
The CRP Accelerated Sludge Digestion System is recommended for design loadings up to 0.2 pounds of volatile solids per cubic foot of digestion volume per day, equivalent to primary digestion volume of two-thirds cubic feet per capita for complete treatment plants of 0.45 cubic feet per capita for primary treatment plants.

WATER, SEWAGE AND TRADE-WASTE TREATING EQUIPMENT



CIRCULAR CLARIFIERS

Hardinge Circular Clarifiers are available in sizes up to 200' diameter, either center-column or beam supported for steel, concrete, wood or tile tanks. Sludge scrapers remove settled solids rapidly through central underflow discharge.

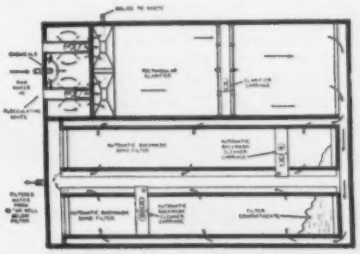


RECTANGULAR CLARIFIERS

Especially suited for limited spaces or where sludge delivery is desired at one end of the tank. A traveling scraper and skimmer carriage removes settled solids from the tank bottom and scum from the top.

HYDRO-CLASSIFIERS

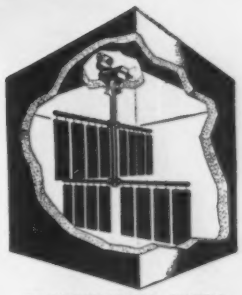
A large-volume classifier for rapid separation of coarse and fine suspended solids. Frequently used for by-product recovery from waste water.



COMPLETE WATER SYSTEM

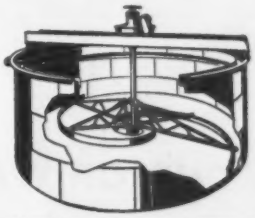
Hardinge also offers a complete water treating unit, combining flocculating equipment, clarifiers and filters in one, common-wall system, using modular construction.

Write for Bulletin 35-D-15



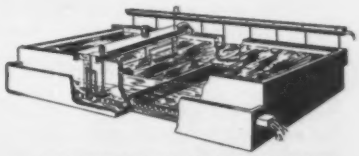
FLOCCULATING UNITS

Slowly rotating paddles on vertical shafts bring the small flocs into contact to form larger masses and hasten precipitation.



"AUTO-RAISE" THICKENERS

For removal of fine suspended solids from supply water, waste water and sewage. "Auto-Raise" mechanism prevents scraper breakage. Manual or power raise supplements "Auto-Raise." Replacement ring-type ball bearing support for rotating mechanism. Spiral rakes for maximum underflow density.



AUTOMATIC BACKWASH FILTERS

For high removal of non-settling or slow settling suspended matter. Self-cleaning sand bed. No shut-down necessary for backwashing. Traveling backwash mechanism.

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 ARCH ST. • Main Office and Works

New York • Toronto • Chicago • Hibbing • Houston • Salt Lake City • San Francisco • Birmingham • Jacksonville Beach

New Bulletins

AVAILABLE FREE

Rota-Rakes

1112

Graver Water Conditioning Co., New York, N. Y., has available a new bulletin on Rota-Rake Clarifiers and Thickeners, water and liquid treatment units. It will be of great interest to all users of horizontal flow gravity separation equipment.

The new bulletin contains drawings and data on the main Rota-Rake model types. These include bridge-supported and center-post designs from 10 ft. dia. or sq. to over 150 ft.

Included is a description of Rota-Rake operation and discussion of design features such as the submerged orifice plate water collection system, the heavy-duty box-truss scrapers, Protecta-Trol overload recorder and the hydraulic lifter for the sludge scrapers.

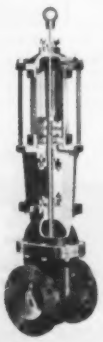
A CUP OF WATER

"'Tis a little thing," the poet says, "to give a cup of water." Yet water, an absolute necessity even in the most primitive society, has had to be rationed in over 1,000 prosperous U. S. communities in the past 5 years. Rainfall has been normal. But water use has increased much faster than improvements in water distribution facilities. Suburban development means more footage of water main per customer.

Some 60% of the water utilities in prosperous U. S. need major improvements now in their distribution systems. For the next 20 year period the U. S. Department of Commerce estimates water works and sewerage works construction requirements at over $41 billion, which is about equal to the total estimated replacement value of existing facilities. This will require construction expenditures at approximately double the current rate.

So, "to give a cup of water" in these modern times has ceased to be a little thing. Your water works superintendent knows the technical side of the problem. But he needs the moral support of his water consumers.

This series is an attempt to put into words some appreciation of the water works men of the United States.



M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF W WALWORTH

Propeller Meters

1113

Measure-Rite, Inc., a subsidiary of Badger Meter Mfg. Co., Alhambra, Calif., has published an attractive 4-page, 2-color brochure on their propeller meters for measurement of liquids.

Amply illustrated the brochure presents a keyed drawing of the advantages inherent in the design of the Measure-Rite meters, an illustration of the varied mounting positions for the meters, and photographs of the different models currently available.

A table giving specifications of the meters and the other services available from the company complete the brochure.

Chicago Pump's Gold Brochure

1114

Chicago Pump Co., Chicago, Ill., as part of its' 50th anniversary, has published a comprehensive gold brochure portraying the research, development and many of the new products introduced by the company since its founding in 1909.

As attractive display of the many new products, systems and equipment supplied to the field of sewage and industrial wastes treatment is diagramatically illustrated. Likewise, a portrayal of the many building and sewage pumps appears on a 2 page spread in this brochure.

Cast Iron Pipe

1115

Griffin Pipe Division of Griffin Wheel Company, Chicago, Ill., has published a booklet entitled "Introducing Griffin Pipe."

This attractive 12-page, 2-color booklet describes the new "Griffin-20" cast iron pressure pipe, and Griffin's manufacturing facilities.

High Capacity Dry Feeder

1116

B-I-F Industries, Inc., Providence, R. I., has just published a bulletin on the Omega Hi-Weigh Belt Gravimetric Feeder, a high capacity feeder for continuously weighing and feeding dry materials at high rates.

The four-page, two-color bulletin contains several photographs of the feeder and a cutaway view illustrating the patented Sens-A-Gram, a me-

chanical controller which instantly responds to the slightest deflection of the weight sensing section of the feed belt. Also included are installation photographs, dimensional drawings, a list of accessories, and a description of the advantages and operation of the feeder.

Features of the Hi-Weigh are discussed. These are: Heavy Duty Belt with positive chain drive for the elimination of slippage and training, High Accuracy Feeding to ±1 percent by weight within range, High Feed Rate of over 3,000 pounds per minute, 100:1 Range, Rapid Rate Setting, exceptionally long life, etc.

Ductile Iron Regulation

1117

OPW-Jordan, Cincinnati, Ohio, has released a new 4-page bulletin on ductile iron regulators and control valves. Bulletin J-DI is also a condensed catalog and fully illustrates all Sliding Gate and Plate Regulators and Control Valves now available in ductile iron. Bulletin describes in detail the composition, properties, specifications, comparison tables on steel, cast iron, and red brass, and the results of a severe quence test on ductile iron valves. It explains how ductile iron is able to replace steel in many applications at a considerable cost savings. Also, illustrates and describes the patented sliding gate seats which are available in all OPW-Jordan regulators.

Water Filters

1118

Neptune Filter Company, Inc., Cranston, Rhode Island, has available a new, instructive four page brochure containing all details and sizes of their line of water filters.

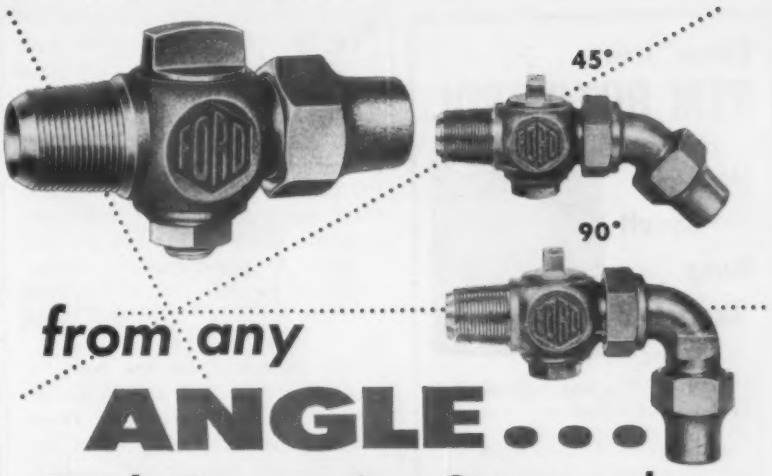
Primarily intended for the use of architects, engineers, and builders, this new Neptune Bulletin is not a sales publication but a strictly technical work that contains design characteristics, capacity chart, and filter data.

Sewage Relief Valve

1119

Golden-Anderson Valve Specialty Company, Pittsburgh, Pa., has just released a bulletin that fully described a new Sewage Surge Relief Valve. Designed to prevent damage from

CONTINUED ON PAGE 106A



from any ANGLE . . .

Ford Corporation Stops make easier installation and service

They are heavy and substantial, made of the finest waterworks bronze with accurate and carefully machined threads. Broad flats on the keys are easily turned with a wrench. Outlets are made for flare type connection to copper tubing.

F-600 CORPORATION STOPS—AWWA standard threads at inlet. Available in sizes ⅝", ⅝" x ¾", ¾", and 1".

F-700 CORPORATION STOPS — American National pipe threads at inlet. Available in sizes ¾" and 1".

All Ford Corporation Stops are shipped in special cartons to protect against damage and dirt.

A real convenience in handling, storing and taking inventory.

Prices will be gladly quoted. Include model number, sizes and quantities.

THE FORD METER BOX COMPANY, INC.
Wabash, Indiana

FOR BETTER WATER SERVICES FORD

VALVE OPERATION

DEAN TRUCK MOUNTED VALVE OPERATOR

MAKES EVERY VALVE POWER OPERATED

PAYNE DEAN & CO. CLINTON, CONN.

New Item . . .
RTM ROTO-TROL
Multi-Circuit Pump Controller

- Recording and Indication when Desired
- Suppressed Head Type
- Any Distance between Transmitter & Receiver

The RTM Roto-Trol operates on the time impulse principle. A tested and proved switching mechanism is operated by a powerful dual motor drive. The motor starters can be controlled direct from the heavy duty mercury switches.

Write for New Bulletin RTM

HEALY-RUFF Company
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FOR OVER 60 YEARS!
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WATER PURIFICATION EQUIPMENT
CALL OR WRITE
MECHANICAL EQUIPMENT BY ROBERTS FILTER MFG. CO. DARBY, PENNA.

New Bulletins

CONTINUED FROM PAGE 105A

overpressure in sewage lines, the new valve opens immediately and automatically whenever the line pressure exceeds a predetermined setting. When the pressure returns to normal the valve is slowly "cushioned" to the tightly closed position.

The bulletin illustrates how the new valve gives full pipe flow with minimum interference. It is shown that there are no small parts to clog and only one moving part, a large rubber faced disk, to contact the flow.

Pug Mill Type Lime Slaker

1120

Omega division of B-I-F Industries, Inc., Providence, R. I., has released a bulletin on the Pug Mill or paddle type Lime Slaker for automatic high efficiency lime slaking.

The four page bulletin explains the design and operation features and explains the reasons behind Omega's development of this modern Lime Slaker. A schematic drawing as well as photographs of installations of the Pug Mill Lime Slaker being used in conjunction with the Omega Loss-In-Weight Lime Feeder are included in the bulletin. A full page is devoted to the ideal method of controlling water to this type of slaker.

Submersible Motor Fact Sheet

1121

Franklin Electric Co., Inc., Bluffton, Indiana, has published a new 4-page, 2-color folder that includes description and availability data of Franklin submersible integral motors. Modular design permits "stacking" of submersible motors for 6" well pumps to provide tandem units in a broad rating range through 40 H.P.

Holloshaft Turbine Pump Motors

1122

U.S. Electrical Motors Inc., Los Angeles, Calif., has just released a brochure lavishly illustrated in full color, on its completely new Holloshaft Turbine Pump Motors for outdoor service. The cover of the new brochure shows the Holloshaft motor pumping under storm conditions, and

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Trade Mark Reg. U.S. Pat. off.
THE MODERN ALL-PURPOSE
FILTERING MEDIUM
Best for All Types of Filters
ANTHRAFILT
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ANTHRACITE EQUIPMENT CORP.
Anthracite Institute Bldg.,
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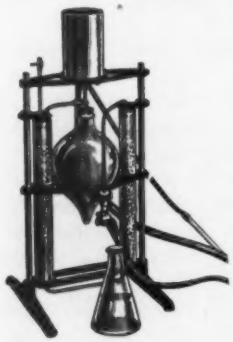


For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

WRITE:
Phipps & Bird, Inc.
P. O. Box 2V Richmond 5, Va.

the first inside spread is devoted to a large, easily-read cut-away view of the motor, with call-outs to the principal features.

The copy explains the story behind the new Holloshaft, and the principles of its design in which a relationship between form and function is introduced for the first time by U.S. design engineers. Throughout the brochure, new design features—such as the revolutionary U.S. Lubriscope fast oil-filling lubrication system—are fully illustrated and explained.

Plastic Pipe Specification Manual

1123

Franklin Plastics, Inc., Franklin, Pa., has just released a specification manual on rigid and semi-rigid plastic pipe for use in the chemical, mining, petroleum, public utilities, commercial and residential plumbing fields.

According to the manual, the company's line of Dur-X ABS pipe, made from acrylontirile-butadiene-styrene resins, and is available in extruded sizes ranging from ⅛-in to 6-in OD with Schedule 80 pipe manufactured with threaded fittings. All other type of the company's pipe and fittings may be solvent-welded without threads.

The manual tells how this pipe may be used for all types of service lines where corrosion may be a big problem in transmitting liquids of waste and corrosive salt solutions, organics that contain wet corrosives such as crude oil, foodstuffs, fine chemicals that cannot be contaminated by metallic substances and lines that are buried in corrosive soil conditions. It may also be used to replace metal and noncorrosive service lines for electrical conduit, city gas feeders, water wells, lawn sprinkling systems, and for many other types of installations.

Sewertite Joint Compounds

1124

Philip Carey Mfg. Co., Cincinnati, Ohio, has available two new single page description sheets listing data and specifications of cold applied Carey Sewertite Asphalt Base and Tar Base Joint Compound for sewer pipe, culvert and septic tank joints of concrete, vitrified clay and tile. Condensed information includes: product description, uses, features; performance data regarding non-volatile matter, inorganic filler, chemical resistance, workability, condition in container and application. Easy-to-read tabular guide lists coverage for tongue and groove pipes from 12" to 108" and bell and spigot joints from 4" to 36".

Dow Products Catalog

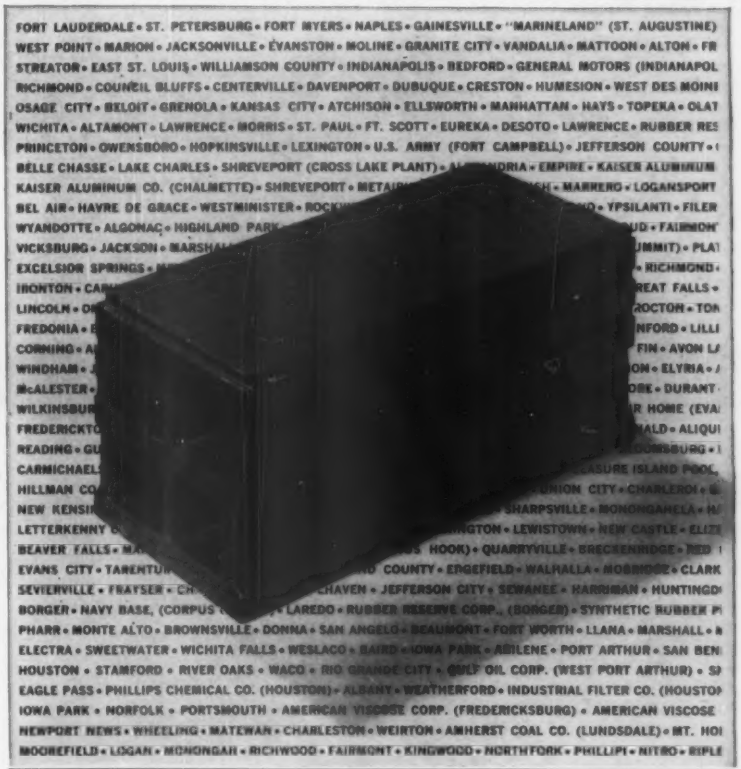
1125

The Dow Chemical Company, Midland, Mich., has available the 1959-1960 edition of their general catalog.

This 44-page compilation, "Products of the Dow Chemical Company," lists the properties and uses of some 375 industrial, pharmaceutical, and agricultural chemicals currently produced. The listing includes established products and developmental items.

The new edition features an expanded section on plastics and coatings products. New sections are included on oxazolidinones, automotive chemicals, textile fibers, and the company's Dowell division.

CONTINUED ON PAGE 108A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Leopold bottoms were chosen for Montebello plants #1 and #2 following their proven performance in the 120 M.G.D. Ashburton plant, where they were installed in 1956. The three plants will have a combined capacity of 360 M.G.D.

Made of de-aired fire clay—vitrified and salt glazed, the Leopold filter bottom can't be matched for dependable, economic service. Individual Leopold blocks can't corrode or absorb water . . . are acid and alkali resistant . . . not subject to tuberculation . . . provide equal filtration and uniform wash distribution. For modernization or new construction, consider the long term economy and performance offered only by Leopold filter bottoms. Write today for complete information.

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New Bulletins

CONTINUED FROM PAGE 107A

Vertical Solid and Hollow Shaft Motors

1126

The Ideal Electric & Manufacturing Co., Mansfield, Ohio, has released a 16-page bulletin covering vertical squirrel cage induction, synchronous and wound rotor motors, 150 hp. and up, frames 584 and larger. It describes and illustrates 15 variations as regards scope, design, applications, dimensions and enclosures. Bearing selection chart, comparative costs of motor type, specifications and normal torques are included. Cutaway illustrations give a graphic description of outstanding construction and ventilation features. A review of selection data is compiled as a buyer's guide.

Turnkey Sewage Treatment Plant

1127

Municipal Service Company, Kansas City, Missouri, has announced the publication of a new bulletin that describes "Suburbia" a low cost sewage treatment plant, furnished and installed on a "turnkey" basis, sufficiently large to provide immediate, adequate sewage treatment for small-but-expanding populations—yet built to expand easily to several times their initial capacities.

Concrete for Water and Sewage Works

1128

The Master Builders Company, Cleveland, Ohio, has published a bulletin describing how concrete in water and sewage works is exposed to the most severe conditions: weathering, freezing and thawing, saturation with water and chemical corrosion. Owners reports and studies of 35 installations contained in this 20-page publication document the outstanding high performance obtained under actual operating conditions through the use of Pozzolith concrete.

Discussion includes factors to be considered for proportioning of concrete for severe exposure conditions to produce low permeability and high durability.

Water and Sewage Instrumentation

1129

Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., offers, in booklet form, a compilation of article reprints from *Instrumentation* Magazine, that discusses some field-proven answers to the many questions on instrumentation as applied to water and sewage treatment. What instruments water and sewage plants use, how they are used, and the job they do in controlling automatically the many variables in water and sewage treatment processes.

Plastic Pipe Technical Data

1130

American Hard Rubber Company, Div. Amerace Corporation, Butler, N. J., has available a 16-page technical bulletin describing Ace-Ite, a general purpose rigid plastic pipe for processing industries, utilities, irrigation, mining, farming, marine, and general industrial use.

According to the bulletin Ace-Ite is a chemical-resistant Type I ABS material, noted for its exceptional impact strength and toughness. Nontoxic, odorless and tasteless, it is ap-

proved by the National Sanitation Foundation for use with drinking water. This new bulletin is exceptionally complete in its technical data, covering fittings and valves as well as pipe.

Fume Hoods

1131

Kewaunee Manufacturing Company, Adrian, Michigan, has just published a 48-page catalog illustrating and describing their complete line of Fume Hoods.

Types of hoods available are: Airflow Supreme, Auxiliary-Airflow, Airflow Thinwall, Improved Conventional, Specific Purpose and Flexihoods. The catalog also includes elevation, duct location and roughing-in drawings; face velocity and CFM recommendations; blower data; and hood service and electrical fixtures.

Gravity Sewer Pipe

1132

Keasbey & Mattison Company, Ambler, Pa., has published a 4-page folder on asbestos-cement gravity sewer pipe, designed for economical, long life non-pressure sewer systems.

Profusely illustrated, it points up savings in design, installation and operation with K&M asbestos-cement pipe. Complete dimensions, tolerances as well as other specifications needed by the engineer are included.

Coal Tar Epoxy Coating Tests

1133

Amercoat Corporation, South Gate, California, has released a compilation of 17 laboratory tests showing what to expect when coal tar epoxies are exposed to attack of various corrosive solutions and environments. Tests include salts, acids, caustics, bleach, petroleum products, distilled water and weathering. Comparative performances of four leading coal tar epoxies illustrated and described for each test.

In-Stream Flow Transmitter

1134

Builders-Providence div., B-I-F Industries, Inc., Providence, R. I., has just released a bulletin on their new, in-stream Chronoflo Transmitter which eliminates stilling wells and expensive maintenance.

According to the bulletin, the transmitter was designed specifically for water, sewage, and industrial waste applications. It is for installation on Parshall Flumes, weirs and other head-area devices for the accurate measuring of rates of flow in open channels. The new transmitter is in-stream actuated, and utilizes a unique type of float arrangement with the 6" expanded polystyrene float riding directly in the channel at the proper metering location. Float motion is vertical with no radial correction necessary.

The two-page bulletin contains a cut-a-way installation photograph of the unit, descriptive text, features, capacities and a section on its method of operation. A line drawing shows component parts of the transmitter and gives dimensions helpful to installation.

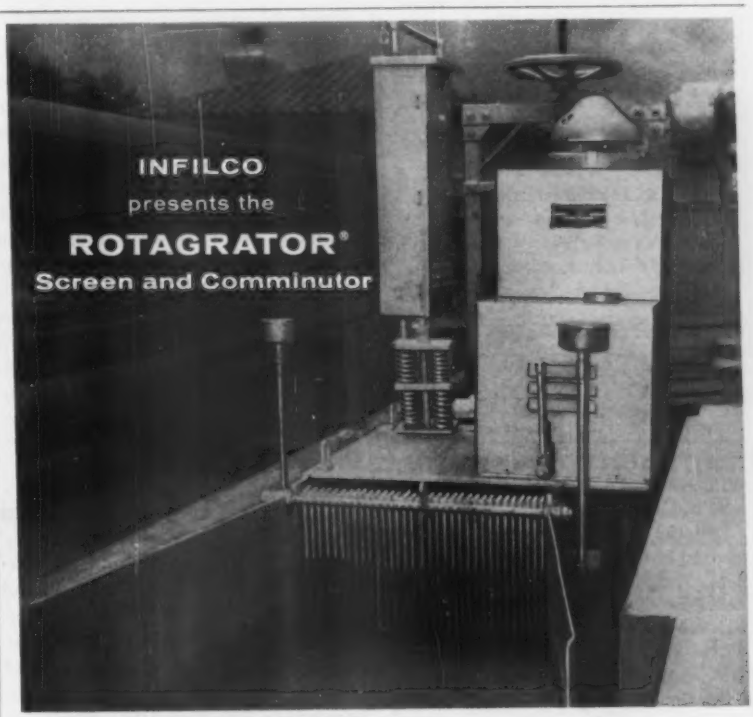
Flexible Couplings

1135

Chain Belt Company, Milwaukee, Wis., has published a revised bulletin on roller chain flexible couplings.

The bulletin outlines the advantages that are wanted and needed from a flexible coupling including: simple, all-steel construction that assures long life and maximum service; accommodation of angular and parallel misalignments with minimum backlash; and easy installation or removal.

In addition, the bulletin carries information on how to properly select Rex flexible couplings and illustrates installation and maintenance procedures.



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No matter what the load may be, the unit operates continuously without harm to the mechanism, because of its rugged construction and safety devices incorporated in its design.

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5842I-A

POSITION AVAILABLE

Written applications are now being accepted for the position of Superintendent of a Sewage Treatment and Refuse Disposal Plant designed to serve 40,000 people in Bradford, Pennsylvania, area. This plant, now under construction, is scheduled for commencement of operation in the summer of 1960. Services of the Superintendent are desired in advance of operation to assist with supervision of equipment installation. Plant facilities include refuse incinerators, sludge incinerator, vacuum filter, chemical precipitation equipment, etc. Salary will be commensurate with ability.

Application shall be made only in writing, in duplicate, and should state experience, education, age, present salary, expected salary and any recommendations, and should be addressed to:

Mr. R. J. Brennan, Chairman
Bradford Sanitary Authority
101 Main Street
Bradford, Pennsylvania

All replies will be strictly confidential.

WATER SUPERINTENDENT. The Village of La Grange, Illinois, is seeking applications for the position of Water Superintendent. Will have charge of complete water works system, including treatment and distribution. 3 MGD plant. Lime-soda ash-zeolite softening process. Salary $7,200-$8,520. Attractive fringe benefits. Apply submitting resume' of education and experience to Robert E. Meyer, Village Manager, La Grange, Illinois.

BASIC CHEMICAL SPECIALTY MANUFACTURER selling odor and waste control products to industry, municipalities and institutions desires man to head Technical Sales Department. Sanitary Engineering/Sales background helpful but not essential. Excellent opportunity. Reply box 6070 Water & Sewage Works.

New Bulletins

CONTINUED FROM PAGE 109A

Control Valves

1136

DeZurik Corporation, Sartell, Minnesota, has announced the release of a new bulletin describing its complete line of control valves. The new bulletin lists valve bodies and actuators and the accessory line available for DeZurik Control Valves. Valve sizing data is also included in the bulletin.

A complete description of the DeZurik Eccentric Principle is diagrammed, and primary advantages of the valves are listed.

Submersible Pumps

1137

Layne & Bowler, Inc., Memphis, Tenn., has just released a new informative bulletin entitled "Submersible Pumps". Detailed cross section drawings plus colored illustrations of the many and varied uses and applications of Layne Submersible Pumps make up the bulletin. Applications covered include: Plant Water Systems, Irrigation, Reservoir Pumping, Municipal Primary Water Supply.

Propeller and Mixed Flow Pumps

1138

Layne & Bowler, Inc., Memphis, Tenn., has released a bulletin entitled "Layne Propeller and Mixed Flow Pumps". Complete and detailed information includes: cut away drawings, installation sketches and measurements, delivery and performance tables, plus complete information on all uses and applications of these pumps.

Laboratory Maintenance Guide

1139

Kewaunee Manufacturing Company, Adrian, Michigan, has just released a 6-page Maintenance Guide.

It describes maintenance and refinishing methods for most types of laboratory work surfaces. The various Top Finishes, Cements and Air Dry Enamels available are described with prices. In addition, the most commonly used Laboratory Service Fixtures are illustrated, described and priced.

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Excellent opportunity for capable and experienced sales engineer with long established machinery manufacturer. Man we need will have from five to ten years experience in treatment of sewage and industrial wastes,—preferably with engineering degree. He must be personable and aggressive, with ability to work with operating engineers and executives. Headquarters: New England area. This is a top level opportunity requiring a seasoned sales engineer in a specialized field who can justify an attractive salary. All correspondence held confidential. Send resume to Box #6060.

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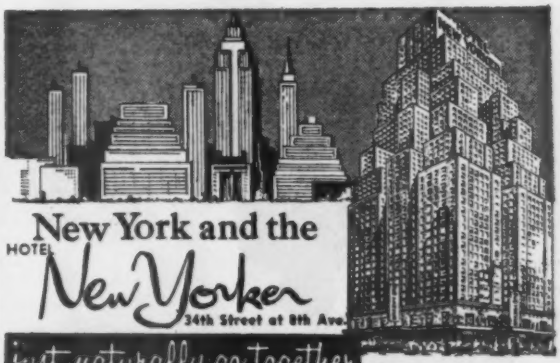

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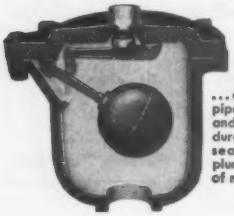

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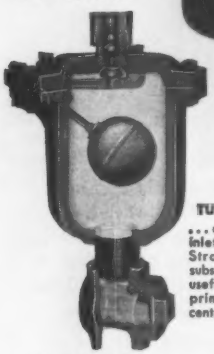

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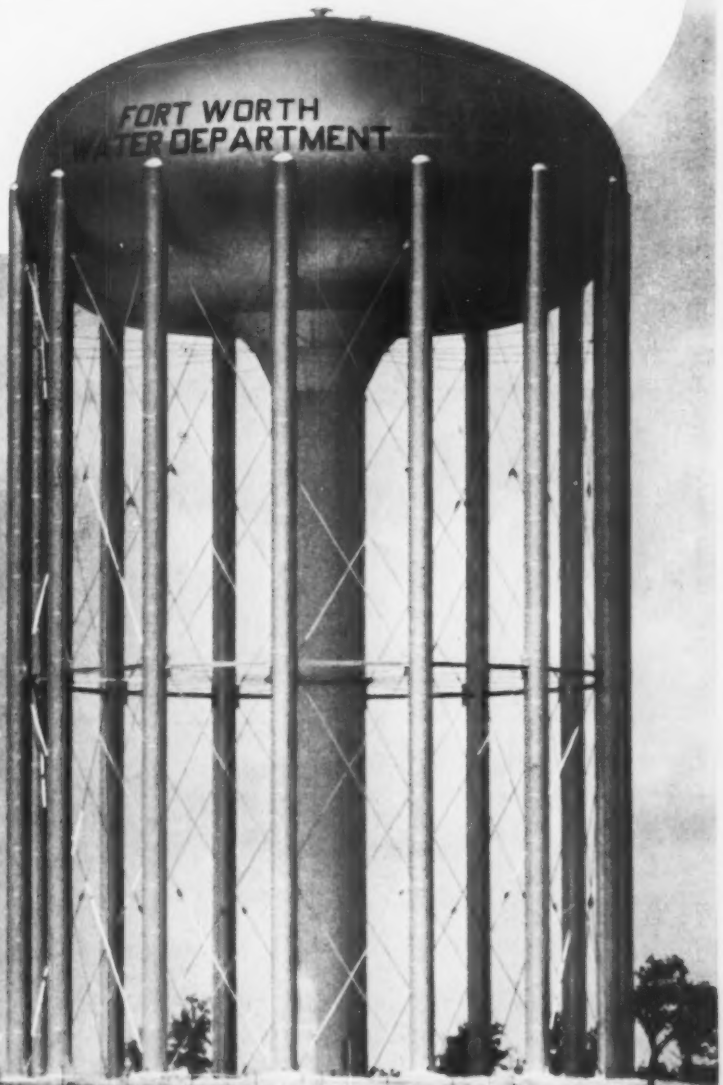

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